AVIGATION/RNAV

APPLICATION PAC PROPOSAL
for the
HP-41C/41CV

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AVIGATION/RNAV
PREFACE

For many years pilots have depended on a sliderule type of flight computer, plotter, and sectional maps for flight planning. Now there are available various calculators to replace the sliderule flight computer, and some at very reasonable prices such as the "Avstar". Some calculators even have numerous aviation programs built into them.

What has been offered is not enough and doesn't really meet the needs of the pilot. This problem was observed in the March 1981 issue of Commuter Air, "Most of the...programs built into these calculators are of relatively little practical use to the commercial operator..." And a pilot writting in the Proffessional Pilot, April 1981 stated, "At this time I can only recommend three units for Rnav use; Texas Instruments' TI59 and Hewlett Packard's HP67 and HP41C models. Unfortunately, off the shelf Rnav programs that truly meet the requirements of the "real world" Rnav have not been developed by these manufacturers. ... Hopefully this will change as the use of programmable calculators for Rnav grows."

The average proffessional pilot, flying in the present sophisticated ATC system needs and is willing to use a good navigation computer. When the flight department can offord it, they will use very sophisticated and expensive ground and airborne computers. Most departments, however, cannot afford what is available.

When pilots see the HP41C being used for Rnav planning, they are impressed and desire one for themselves. Until they find out they have to program it themselves for the capabilities needed. Not everyone has the desire or time needed to do the programming, and few capable enough mathematically to do it. Nor is it easy to find someone else to do the programming for the pilot, because even if they are capable, they do not understand the world of the cockpit.

A practical aviation program needs to be offered to the aviation world that meets their needs and is supplemented with programs such as weight and balance, TAS, Mach, wind, flight management, etc. The proposed program meets this need. It provides preflight planning as well as inflight route changes; it provides for all types of navigation fixes, not only airports and vortacs, but intersections and Rnav waypoints as well. It is this program which is most needed by the average proffessional pilot who flys IFR and/or Rnav, and which can meet their real world needs. It will make the HP41C a viable and justifiable tool to the general aviation community and flight departments, which will result in an increase of HP41C system sales.

This program is submitted to Hewlett Packard for consideration to help meet the challange presented by the aviation market.

Robert A. Tims
10-14-81

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LBL'AVNAV
AVIGATION/RNAV

PROGRAM DESCRIPTION I

Program Title AVIGATION - AVIATION NAVIGATION

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables This program prompts for navigation fixes and computes the course and distance for each leg. These primary legs, if desired, can be divided into secondary legs by Area Navigation (RNAV) Waypoints. The individual legs, with their associated data, are stored in proper sequence; each leg in 5 data registers.

The primary legs have starting and terminating fixes determined by latitude and longitude coordinates; or if desired, as an intersection or waypoint defined by a heading or radial and by a distance from the coordinates of the reference fix.

The program will, if desired, calculate a waypoint over the departure and destination airports.

Each leg has its starting fix Identifier stored with the next register the waypoint fix if the fix is a waypoint. The true course and distance is stored next, followed by the altitude and magnetic variation. The final leg data will be the interpolated wind for that altitude.

At anytime a waypoint is not desired (either a terminal or enroute WP) input may be declined. Input is declined by resumning program execution with R/S. The flight may be terninated by declining the next primary leg terminating fix; the program will them prompt for the destination waypoint. Finally the airport elevations and climb/descent winds are prompted for, also the performance data. Program execution is then passed to the Aviation Fly Program.

Necessary Accessories A card reader is recommended.

Operating Limits and Warnings The following subroutines are used: "NFIX", "CRS", "WP", "TWP", "WIND", & "PRF". If a mistake is made on data entry, the program must be started over. Ident may be corrected as long as the incorrect isn't in the data registers.

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Flight: Depart the McGhee Tyson airport, Knoxville, TN; fly direct to COWAN intersection with WP's off of Hinch Mt. Vortac and Chattanooga Vortac; Thence V54N to the Rocket Vortac, V54 to Muscle Shoals Vortac, and direct to Muscle Shoals, AL airport.

Coordinates:

McGhee Tyson - TYS 981' Elev.
35°48'45"N 83°59'34"W, 1°W

Knoxville Vortac - TYS (on Data Card - TYSV)
35°54'17"N 83°53'41"W, 1°W

Hinch Mt. Vortac - HCH (on Data Card - HCHV)
35°46'51"N 84°58'43"W, 1°E

Chattanooga Vortac - CHA (on Data Card - CHAV)
34°57'40"N 85°09'12"W, 1°E

Rocket Vortac - RQZ (on Data Card - RQZV)
34°47'49"N 86°38'02"W, 2°E

Muscle Shoals Vortac - MSL (on Data Card - MSLV)
34°42'24"N 87°29'29"W, 1°E

Muscle Shoals - MSL 550' Elev.
34°44'43"N 87°36'37"W, 1°E

FORECAST WINDS ALOFT

	3000'	6000'	9000'
TYS	0410	0615	0718
CHA	0610	0918	1124
MSL	0710	1125	1530

AIRCRAFT PERFORMANCE

Climb: TAS 115 kts, F/F 54 gph
Cruise: TAS 180 kts, F/F 34 gph
Descent: TAS 190 kts, F/F 24 gph
ROC 900 fpm, ROD 500 fpm

Data from Weight & Balance:
Gross Wt. 5000 lbs
Fuel 100 gal. = 600 lbs

SOLUTION:

PERTINENT DATA REGISTERS

AVNAV RESULTS USED LATER
IN THE AVFLY PROGRAM

R10= 70

R14= 4000
R15= 192

R19= 981.0000
R20= 50.0125
R21= 550.0000
R22= 70.0100
R23= 115.0000
R24= 180.0000
R25= 190.0000
R26= 900.0000
R27= 500.0000
R28= 54.0000
R29= 34.0000
R30= 24.0000

R33= 34.745
R34= 0.000
R35= 600.000
R36= 5000.000
R37= "WP:TYS"
R38= 2218.007

R40= "TYS"
R41= 0.0000
R42= 244.0440
R43= 8000.0010
R44= 67.0170
R45= "WP:HCH"
R46= 1531.0193
R47= 244.0290
R48= -8000.0010
R49= 103.0220
R50= "WP:CHA"
R51= 3331.0211
R52= 244.0320
R53= -8000.0010
R54= 103.0220
R55= "COWAN"
R56= 0.0000
R57= 247.0380
R58= -4000.0010
R59= 70.0127
R60= "RQZV"
R61= 0.0000
R62= 263.0430
R63= -4000.0020
R64= 83.0150
R65= "MSLV"
R66= 0.0000
R67= 292.0060
R68= -4000.0010
R69= 83.0150
R70= "MSL"

Comments

LEG #1 Data

LEG #2 Data

LEG #3 Data

LEG #4 Data

LEG #5 Data

LEG #6 Data

Destination Identifier

SOLUTION:

PROGRAM DESCRIPTION II

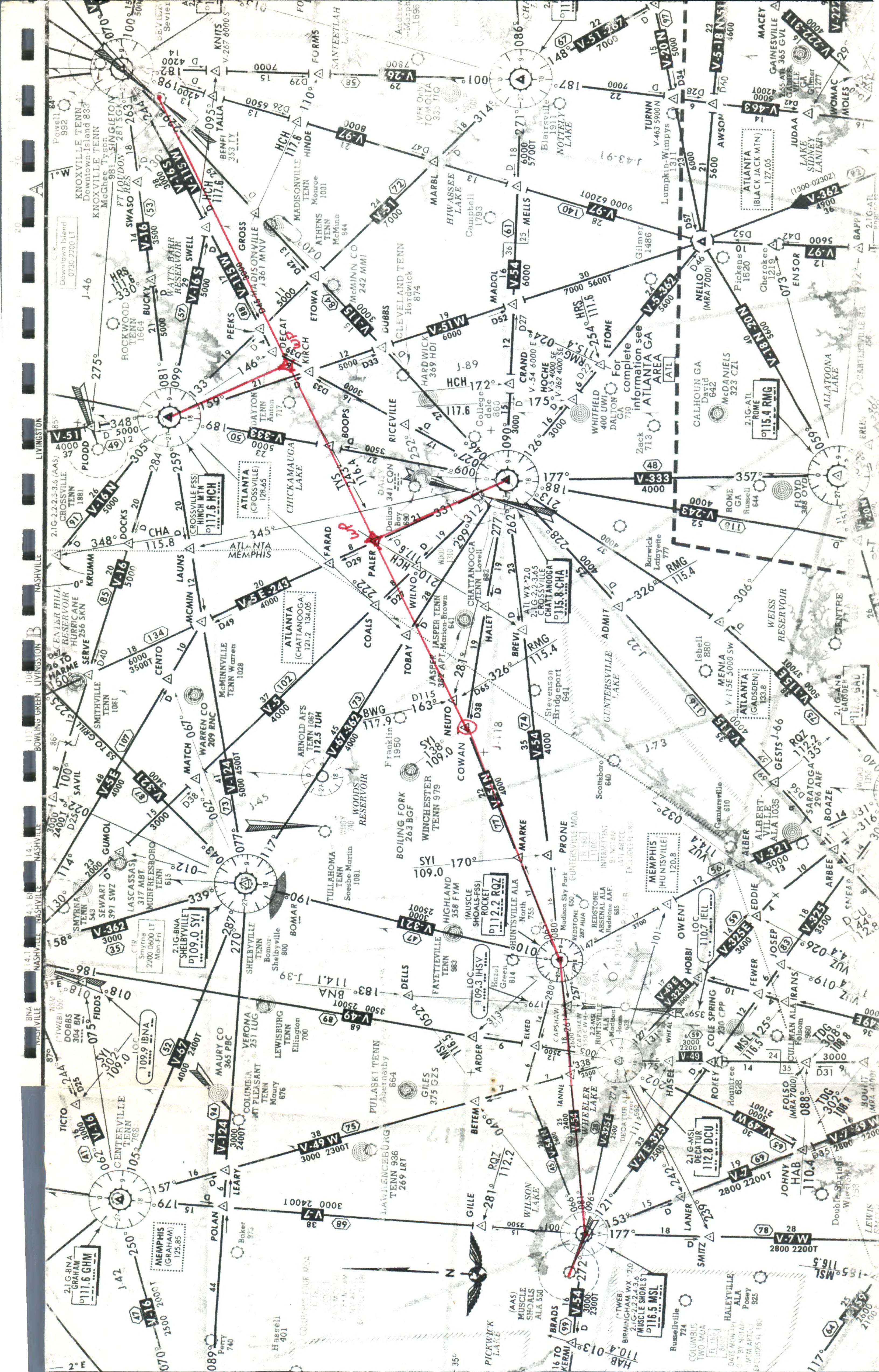
Input	Function	Display	Comments
	XEQ AVNAV	FROM?	Asking for Departure airport
TYS	R/S	CARD	TYS isn't on the data card, but
	Load Data Card	TYS LAT?	load card for next fix to save
35.4845	R/S	TYS LNG?	having to push R/S twice to
83.5934	R/S	TYS VAR?	continue the program.
1	R/S	TYS WP?	
TYSV	R/S	TYS TO?	
COWAN	R/S	CARD	COWAN INTERSECTION IS 277°, 38 DME
	R/S	COWAN	from CHA Vortac.
	R/S	COWAN LAT?	
	R/S	NEED FIX?	
CHAV	R/S	LEG MC?	
277	R/S	LEG DIST?	
38	R/S	TYS TO WP?	
HCHV	R/S	ALT=0?	
8000	R/S	WA6?	Use TYS Winds
060.015	R/S	WA9?	
70.018	R/S	WP:HCH TO WP?	
CHAV	R/S	ALT=8000?	
	R/S	WA6?	
90.018	R/S	WA9?	Use CHA Winds.
110.024	R/S	WP:CHA TO WP?	
RQZV	R/S	WP:CHA TO WP?	RQZ improper waypoint, it is
	R/S	ALT=8000?	beyond terminating fix.
	R/S	WA6?	Same altitude and winds
	R/S	COWAN TO?	
RQZV	R/S	COWAN TO WP?	
	R/S	ALT=8000?	
4000	R/S	WA3?	
	R/S	WA3?	New altitude, need new winds!
60.01	R/S	WA6?	Use CHA winds
90.018	R/S	RQZV TO?	
MSLU	R/S	CARD	Spelling mistake
	R/S	MSLU	
	R/S	MSLU LAT?	
	R/S	NEED FIX?	
	R/S	LEG MC?	
	R/S	MSLU	
MSLV	R/S	RQZV TO WP?	
	R/S	ALT=4000?	
	R/S	WA3?	
70.01	R/S	WA6?	Use MSL Winds
110.025	R/S	MSLV TO?	
MSL	R/S	CARD	
	R/S	MSL	
	R/S	MSL LAT?	
34.4443	R/S	MSL LNG?	
87.3637	R/S	MSL VAR?	
-1	R/S	MSLV TO WP?	
	R/S	ALT=4000?	
	R/S	WA3?	Same altitude, same winds.
	R/S	MSL TO?	Terminate flight as MSL is the
	R/S	MSL WP?	Destination airport
	R/S	DEPART EL?	Terminal waypoint is declined.
981	R/S	WA3?	
40.01	R/S	WA6?	Using TYS winds
60.015	R/S	DEST EL?	
550	R/S	WA3?	Use MSL Winds

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

SOLUTION:

Input	Function	Display	Comments
70.01	R/S	CLIMB TAS?	
115	R/S	CRUISE TAS?	
180	R/S	DESCENT TAS?	
190	R/S	R.O.C.?	
900	R/S	R.O.D.?	
500	R/S	CLIMB F/F?	
54	R/S	CRUISE F/F?	
34	R/S	DESCENT F/F?	
24	R/S	Program is transfered to the AVFLY program!	



KNOXVILLE TENN
Downtown-Island 833
KNOXVILLE TENN
McGhee Tyson 981
SINGLETON 281 SGK
FT LOUDON RES
ROCKWOOD TENN 1664
WATTS BARR RESERVOIR
MADISONVILLE 1361 MNV
MADISONVILLE TENN Monroe 1031
ATHENS TENN McMinn 844
McMINN CO 242 MMI
CLEVELAND TENN Hardwick 874
HARDWICK 369 HDI
HIWASSEE LAKE
Campbell 1793
Blairsville 1911
NOTTELY LAKE
Lumpkin-Wimpys 1311
Gilmer 1486
GAINESVILLE 365 GVL
LAKE SIDNEY LANIER
ATLANTA (BLACK JACK MTN) 127.05
For complete information see ATLANTA GA AREA
WHITFIELD 400 UWI
DALTON GA 710
CALHOUN GA David 642
McDANIELS 323 CZL
2.1G-ATL ROME 115.4 RMG
ALLATOONA LAKE
ROME GA Russell 644
FLOYD 388 OYD
CROSSVILLE TENN 1881
CROSSVILLE FSS HINCH MTN 117.6 HCH
ATLANTA (CROSSVILLE) 128.65
CHICKAMAUGA LAKE
DAYTON TENN Anton 717
DAISY 341 CQN
CHA 115.8
ATLANTA MEMPHIS
CENTER HILL RESERVOIR
HURRICANE 256 SKN
SMITHVILLE TENN 1081
McMINNVILLE TENN Warren 1028
ATLANTA (CHATTANOOGA) 121.2 134.05
CHATTANOOGA TENN Lovell 682
ATL WX-*2.0 2.1G-2.2-3.65 CROSSVILLE CHATTANOOGA 115.8 CHA
JASPER TENN Marion-Brown 641
WARREN CO 209 RNC
ARNOLD AFS TENN 1067 112.5 TUH
BWG 117.9
Franklin 1950
SYI 109.0
WOODS RESERVOIR
BOILING FORK 263 BGF
WINCHESTER TENN 979
Stevenson-Bridgeport 641
GUNTERSVILLE LAKE
Scottsboro 640
Isbell 880
ATLANTA (GADSDEN) 133.8
WEISS RESERVOIR
ALBERTVILLE ALA 1035
SARATOGA 296 ARF
Guntersville 610
MEMPHIS (HUNTSVILLE) 120.8
SMYRNA TENN 543
SEWART 391 SWZ
LASCASSAS 317 MBT
MURFREESBORO TENN 615
CTR Smyrna 2200-0600 LT Mon-Fri
2.1G-BNA SHELBYVILLE 109.0 SYI
SHELBYVILLE TENN Bomar-Shelbyville 800
TULLAHOMA TENN Soesbe-Martin 1081
HIGHLAND 358 FYM
(MUSCLE SHOALS-FSS) ROCKET 112.2 RQZ
HUNTSVILLE ALA North 755
Madison Sky Park 650
REDSTONE 287 HUA
REDSTONE ARSENAL ALA Redstone AAF 685
LOC 110.7 IELL
LOC 109.3 IHSV
FAYETTEVILLE TENN 983
Hazel Green 814
BNA 114.1
DOBBS 304 BN
LOC 109.9 IBNA
MAURY CO 365 PBC
COLUMBIA MT PLEASANT TENN Maury 676
VERONA 251 LUG
LEWISBURG TENN Ellington 700
PULASKI TENN Abernathy 664
GILES 375 GZS
CENTERVILLE TENN 768
LAWRENCEBURG TENN 936 269 LRT
2.1G-BNA GRAHAM 111.6 GHM
MEMPHIS (GRAHAM) 125.85
CAPSHAW 350 CWH
2.2-MSL HUNTSVILLE ALA Madison Jones
COLE SPRING 230 CPP
CULLMAN ALA Folsom 960
DECATUR ALA Pryor 592
2.1G-MSL DECATUR 112.8 DCU
WHEELER LAKE
WILSON LAKE
Double Springs Winston
(AAS) MUSCLE SHOALS ALA 550
BIRMINGHAM WX 2.0 2.1G-2.2-2.4-3.6 MUSCLE SHOALS 116.5 MSL
PICKWICK LAKE
Russellville 724
HALEYVILLE ALA Posey 925
COLUMBUS TWO MOA
HAB 110.4
V-51 V-16 V-115 V-333 V-5E-243 V-54 V-97 V-51W V-5-362 V-18N-20N V-243 V-362 V-321 V-67 V-124 V-49 V-49W V-7 V-7W V-325 V-325E V-54N V-67-362
J-46 J-89 J-45 J-39 J-42 J-22 J-66 J-73

USER INSTRUCTIONS

SIZE: 41 + 5N

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Size and run weight & Balance. GW in R36, Fuel Weight in R35.			
2	Begin AVNAV		XEQ AVNAV	FROM?
3	Input departure airport identifier.	IDENT	R/S	see Step A
	from Step A (2/7) or Step A skipped.			(ident) WP?
	from Step A (11), skip Step 4			(ident) TO?
4	Input terminal waypoint fix identifier.	IDENT	R/S	see Step A
	from Step A (2/7) or Input declined			(ident)TO?
5	Input identifier for leg terminating fix.	IDENT	R/S	see Step A
	from Step A or Step A skipped.			(ident) TO WP?
6	Input waypoint identifier	IDENT	R/S	see Step A
	Input declined, skip to step 11			
	from Step A			ALT=0?
7	Input Altitude	Alt feet	R/S	WA#?
	If declined displayed altitude will be entered.			
8	Input Wind aloft as required by Alt.	DDD.VVV	R/S	WA#?
	(# thousands of ft = 3,6,9,12,18,24,30,34,40,45,53)			
	Cannot be declined if new altitude or if it is the first leg.			
	If declined, prior wind aloft is entered and step 9 skipped.			
9	Input next higher Wind Aloft if required.	DDD.VVV	R/S	WP:(ident) TO WP?
	If declined, step 8 input will be entered.			
10	Repeat starting with step 6.			
11	Input Alt. & Winds (same as steps 7, 8, & 9)		R/S	(Ident) TO?
12	Input Ident. for new legs term. fix.	IDENT	R/S	see Step A
	If declined skip to Step 14			
	from Step A			(ident) TO WP?
13	Repeat starting with Step 6			

USER INSTRUCTIONS

SIZE: 41 + 5N

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
14	Trip is terminated. Last leg's term. fix is the Destination Airport			(ident) WP?
15	Input terminal waypoint fix identifier from Step A, or input declined	IDENT	R/S	see Step A DEPART EL?
16	Input Departure airport's elevation	Elev.	R/S	WA#?
17	Input Winds (same as steps 8 & 9)	DDD.VVV	R/S	DEST EL?
18	Input Destination airport's elevation	Elev.	R/S	WA#?
19	Input Winds (Same as steps 8 & 9)	DDD.VVV	R/S	CLIMB TAS?
20	Input Aircraft Performance:			
	Climb TAS (if declined skip to 21)	TAS_c	R/S	CRUISE TAS?
	Cruise TAS	TAS_{cr}	R/S	DESCENT TAS?
	Descent TAS	TAS_d	R/S	R.O.C.?
	Rate of Climb	ROC	R/S	R.O.D.?
	Rate of Descent	ROD	R/S	CLIMB F/F?
	Climb Fuel Flow	FF_c	R/S	CRUISE F/F?
	Cruise Fuel Flow	FF_{cr}	R/S	DESCENT F/F?
	Descent Fuel Flow	FF_d	R/S	Transfers tothe AVFLY Program.
21	Prompts for the same information as Step 20, and gives oppourtunity to record the aircraft performance data on a Data Card. then transfers to the AVFLY Program.			

USER INSTRUCTIONS

Coordinate Input Steps – STEP A *

SIZE: 41 + 5N

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	If Card Reader not used, skip to 4.			CARD
2	Load data card: Data not on the card – go to 4.		Data on the card–	return to the original step
3.	Data card not used		R/S	(ident)
4.	Resume program execution		R/S	(ident) LAT?
5.	Input Latitude	LAT	R/S	(ident) LNG?
	If input declined skip to step 8.			
6.	Input Longitude	LNG	R/S	(ident) VAR?
7.	Input Variation (+ W, – E)	VAR	(CHS) R/S	Return to the original step
8.	If waypoint is being calculated the Coordinate Input steps start over.			(ident)
	If not: calculate coordinates			NEED FIX?
9.	If a reference fix needed, enter ident (Uses Step A, 1 – 7)	IDENT	R/S	FIX ~~LEG~~ MC?
	If using the prior fix, decline input	none	R/S	FIX ~~LEG~~ MC?
10.	Input radial or heading from fix	degrees	R/S	FIX ~~LEG~~ DIST?
11.	Input distance from the fix	NM	R/S	Return to the original step

* NOTE: IF THE DATA IS ALREADY LOADED FROM A PRIOR CARD, STEP A IS SKIPPED.

LBL 'AVNAV
END 373 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "AVNAV"	
02	CF 02	
03	CF 29	
04	FIX 0	
05	"FROM?"	
06	SF 01	
07	SF 23	
08	XEQ "NFIX"	Departure coordinates
09	CF 01	
10	RCL 06	Store From Ident.
11	STO 00	
12	CLX	USE 33
13	STO 14	
14	STO 15	
15	STO 38	
16	38	
17	FC?C 03	
18	XEQ "IWP"	Departure WP
19	RCL 00	USE 33
20	STO 06	Recall From Ident
21	40	
22	STO 10	Initialize leg pointer
23	*LBL 20	
24	CLA	
25	ARCL 06	Store Identifier
26	ASTO IND 10	
27	"⊢ TO?"	
28	CF 23	
29	XEQ "NFIX"	Coordinates for Primary
30	FC? 23	leg terminating coord.
31	GTO 22	Flight terminated?
32	XEQ "CRS"	TC and Distance
33	STO 00	TC
34	RCL 02	Distance
35	RND	
36	ST+ 15	
37	STO 05	Primary leg distance
38	RCL 11	
39	STO 31	store leg data
40	RCL 12	
41	STO 32	
42	RCL 13	
43	STO 33	
44	RCL 06	
45	STO 34	
46	RCL 10	
47	1	
48	+	
49	0	
50	STO 04	
51	STO IND Y	
52	SF 02	
53	*LBL 21	
54	CLA	
55	ARCL IND 10	
56	"⊢ TO WP?"	
57	CF 23	
58	XEQ "NFIX"	
59	FC? 23	Waypoint declined?
60	GTO 01	
61	XEQ "CRS"	
62	XEQ "WP"	Compute WP Fix
63	FC?C 07	Waypoint computed?
64	GTO 21	
65	STO 13	
66	RCL 12	
67	ENTER↑	
68	X<> 04	
69	XEQ 10	Leg Dist, Alt, & Wind
70	RCL 11	Update variation
71	STO 07	
72	"WP:"	
73	ARCL 06	
74	ASTO IND 10	WP Ident
75	RCL 10	
76	1	
77	+	
78	RCL 13	WP Fix
79	STO IND Y	
80	GTO 21	
81	*LBL 01	
82	CF 02	
83	RCL 05	
84	RCL 04	
85	XEQ 10	Leg Dist, Alt, & Wind
86	RCL 31	
87	STO 07	Recall Leg Data
88	RCL 32	Terminating Fix
89	STO 08	becomes
90	RCL 33	the Starting Fix
91	STO 09	
92	RCL 34	
93	STO 06	
94	GTO 20	
95	*LBL 10	
96	-	Leg Distance
97	1 E3	
98	/	
99	RCL 00	True Course
100	RND	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
101	+	
102	2	
103	ST+ 10	
104	RDN	
105	STO IND 10	CRS.DIS
106	1	
107	ST+ 10	
108	"ALT="	
109	ARCL 14	
110	"F?"	
111	RCL 14	Last Altitude
112	CF 22	
113	PROMPT	
114	RND	
115	STO 14	New altitude
116	FS? 22	Altitude new?
117	SF 06	
118	RCL 07	VAR'
119	1 E3	
120	/	
121	SIGN	
122	X<>Y	
123	LASTX	
124	ABS	
125	+	
126	*	Alt.var
127	STO IND 10	
128	1	
129	ST+ 10	
130	*LBL 11	
131	RCL 14	
132	XEQ "WIND"	
133	FS? 22	Winds entered?
134	GTO 00	
135	44	Wind cannot be declined
136	RCL 10	if leg is the first or
137	X≠Y?	new altitude entered,
138	FS? 06	otherwise, previous legs
139	GTO 11	wind will be entered.
140	5	
141	-	
142	RCL IND X	
143	*LBL 00	
144	STO IND 10	
145	1	
146	ST+ 10	
147	CF 06	
148	RTN	
149	*LBL 22	
150	CLX	
151	STO 34	
152	34	
153	FC?C 03	
154	XEQ "TWP"	Destination WP
155	CLX	
156	"DEPART EL?"	
157	PROMPT	
158	STO 19	
159	RCL 43	
160	INT	
161	ABS	
162	+	Average climb altitude
163	2	
164	/	
165	XEQ "WIND"	
166	STO 20	
167	CLX	
168	"DEST EL?"	
169	PROMPT	
170	STO 21	
171	RCL 14	
172	+	
173	2	Average descent alt.
174	/	
175	XEQ "WIND"	
176	STO 22	
177	XEQ "PRF"	
178	GTO "AVFLY"	
179	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	True course		
01	scratch		
02	scratch		
03	scratch		
04	WP Dist		
05	Leg Dist		
06	Identifier		
07	VAR'		
08	LNG'		
09	LAT'		
10	Leg pointer		
11	VAR		
12	LNG		
13	LAT		
14	Altitude		
15	Total distance		
16		19	Departure Elev.
to	CARD DATA	20	Climb Wind
30		21	Destination Elev.
31	Leg var	22	Descent Wind
32	Leg lng		
33	Leg lat / Destination WP Ident.		
34	Leg ident / Destination WP Fix		
35	reserved for fuel weight		
36	reserved for gross weight		
37	Departure WP Ident.		
38	Departure WP Fix		
39	not used		
40	Leg #1: Ident		
41	WP Fix		
42	CRS.DIS		
43	Alt.var		
44	Wind data		
45	Leg #2:		
etc.			
40+5N	Destination Identifier		

N is the number of legs.

STATUS

SIZE 41+5N TOT. REG. _____ USER MODE

ENG _____ FIX _____ SCI _____ ON _____ OFF _____

DEG x RAD _____ GRAD _____

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
00		Fuel in LBS	Fuel in US GAL.
01	C	Coord.'	
02	C	Computing waypoints	
03	C	Term. fix is a WP	
06	C	New altitude	
07	C	Waypoint calculated	Improper WP

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

PROGRAM DESCRIPTION I

Program Title AVIATION FLY PROGRAM

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables This program utilizes the data generated by the AVNAV program. It calculates the descent point along the flight path for a continuous descent to the destination airport. Each leg is prefaced with the starting and ending fix identifiers. If the starting fix is a waypoint that fix will be listed next. The magnetic course and leg distance conclude the leg preface. Changes in altitude while in flight are detected and calculated at the first part of the leg. Changes of altitude are output seperately, than followed by the level portion of the leg.

Regardless of how many legs it takes on the first climbout to altitude, the altitude and wind aloft of the first leg is used instead of what was input. The same is true for the descent, the altitude and wind aloft is assigned to the leg in which the descent point falls regardless of what was input originally. This should be taken into account when generating the data with AVNAN Program, especially if the rate of climb or descent is slow.

Necessary Accessories Printer is recommended, but is optional.

Operating Limits and Warnings Data Error will be displayed if a level altitude isn't established prior to the final descent. Care should be taken on assigning altitudes to legs to assure practical climbs and descents.

PROGR[illegible] DESCR[illegible]PTION II

Sample Problem (Sketch if Desired)

The Aviation Fly Program output is listed below, using the data calculated by the Aviation Navigation Program. Execution of the AVFLY program is automatic from the previous program.

XEQ "AVFLY"

TYS TO MSL
T/DIST 192 NM

TYS * WP:TYS
221.8°, 7.3 NM

TYS to WP:HCH
MC=245° DIST=44 NM

CLIMB 981 → 8000
HDG=247°
GS=127
DIST=17
REM DIST=175
FUEL=7.0
REM FUEL=93.0
TIME=0:07:48

LEVEL AT 8000
HDG=245°
GS=197
DIST=27
REM DIST=148
FUEL=4.7
REM FUEL=88.3
TIME=0:08:13
T/TIME=0:16:01

WP:HCH to WP:CHA
153.1°, 19.3 NM
MC=243° DIST=29 NM

LEVEL AT 8000
HDG=239°
GS=197
REM DIST=119
FUEL=5.0
REM FUEL=83.3
TIME=0:08:51
T/TIME=0:24:52

WP:CHA to COWAN
333.1°, 21.1 NM
MC=243° DIST=32 NM

LEVEL AT 8000
HDG=239°
GS=197
REM DIST=87
FUEL=5.5
REM FUEL=77.8
TIME=0:09:46
T/TIME=0:34:38

COWAN to RQZV
MC=246° DIST=38 NM

DESCENT 8000 → 4000
HDG=244°
GS=206
DIST=27
REM DIST=60
FUEL=3.2
REM FUEL=74.6
TIME=0:08:00
T/TIME=0:42:38

LEVEL AT 4000
HDG=246°
GS=193
DIST=11
REM DIST=49
FUEL=1.9
REM FUEL=72.6
TIME=0:03:26
T/TIME=0:46:04

RQZV to MSLV
MC=261° DIST=43 NM

LEVEL AT 4000
HDG=261°
GS=195
DIST=26
REM DIST=23
FUEL=4.5
REM FUEL=68.1
TIME=0:08:00
T/TIME=0:54:04

DESCENT 4000 → 1462
HDG=262°
GS=200
DIST=17
REM DIST=6
FUEL=2.0
REM FUEL=66.1
TIME=0:05:05
T/TIME=0:59:08

MSLV to MSL
MC=291° DIST=6 NM

DESCENT 1462 → 550
HDG=293°
GS=197
FUEL=0.7
REM FUEL=65.3
TIME=0:01:49
T/TIME=1:00:58

LANDING WT= 4792 LBS
RESERVE TIME=1:55:17

HAPPY FLYING

LBL'AVFLY
END 644 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "AVFLY"	
02	CF 07	
03	CF 29	
04	RCL 10	
05	STO 16	Preserve number of registers
06	0	
07	STO 06	
08	STO 09	
09	STO 18	
10	2.96295	
11	ST- 10	Leg pointer value
12	RCL 14	Last leg altitude
13	RCL 21	Destination elevation
14	STO 13	
15	-	
16	RCL 27	ROD
17	/	
18	60	
19	/	
20	STO 11	Time to descend
21	RCL 25	
22	STO 07	Descent TAS
23	♦LBL 10	
24	RCL 13	
25	STO 21	Leg lowest altitude
26	RCL IND 10	
27	STO 05	Leg CRS.DIS
28	SF 06	
29	DSE 10	SF06 if 1st leg
30	CF 06	
31	RCL 22	Descent wind
32	XEQ "WC"	
33	RCL 11	
34	X<=Y?	Enough time for the
35	GTO 11	descent in this leg?
36	X<>Y	
37	ST- 11	Descent time used in leg
38	60	
39	*	
40	RCL 27	ROD
41	*	
42	ST+ 13	Legs highest altitude
43	CLX	
44	FS? 06	Error Trap:
45	LN	Not enough time for descent
46	RCL 10	
47	6	
48	+	
49	RCL IND X	
50	SIGN	
51	LASTX	
52	FRC	Present variation
53	ABS	
54	RCL 21	Leg's lowest altitude
55	RND	
56	+	
57	*	
58	STO IND Y	Low Alt.var
59	GTO 10	
60	♦LBL 11	
61	RCL 02	Groundspeed
62	*	
63	1 E3	
64	/	
65	STO 32	Descent point
66	RCL 10	
67	6	
68	+	
69	RCL IND X	
70	SIGN	
71	LASTX	
72	FRC	Present variation
73	ABS	
74	RCL 14	Last leg altitude
75	RND	
76	+	
77	*	Last leg alt.var
78	STO IND Y	
79	ADV	
80	CLA	
81	SF 12	
82	SF 21	
83	ARCL 40	Departure airport
84	"⊢ TO "	
85	ARCL IND 16	Destination airport
86	AVIEW	
87	CF 12	
88	"T/DIST "	
89	ARCL 15	
90	"⊢ NM"	
91	XEQ "PR"	
92	ADV	
93	CLA	
94	ARCL 40	
95	"⊢ * "	
96	ARCL 37	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'AVFLY
END 644 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
97	RCL 38	
98	X=0?	Terminal waypoint?
99	GTO 00	
100	ADV	
101	XEQ "PR"	
102	XEQ "WPD"	
103	LBL 00	
104	RCL 19	
105	STO 13	Departure elevation
106	SF 05	Climbout indicator
107	RCL 10	
108	INT	
109	2	
110	+	
111	1 E3	
112	/	
113	40	
114	FS?C 06	Descent in first leg?
115	GTO 21	
116	+	
117	STO 10	New pointer value
118	LBL 20	
119	ADV	
120	CLA	
121	ARCL IND 10	
122	ISG 10	
123	FC? 55	
124	GTO 01	
125	ACA	
126	CLA	
127	SF 13	
128	" TO "	Leg Preface
129	ACA	
130	CF 13	
131	CLA	
132	GTO 02	
133	LBL 01	
134	"⊢--"	
135	LBL 02	
136	RCL 10	
137	4	
138	+	
139	ARCL IND X	
140	XEQ "PR"	
141	RCL IND 10	
142	ISG 10	
143	X≠0?	Is the starting fix a
144	XEQ "WPD"	waypoint?
145	FIX 0	
146	"MC="	
147	RCL IND 10	
148	ISG 10	
149	STO 05	CRS.DIS
150	INT	TC
151	RCL IND 10	
152	FRC	
153	1 E3	
154	*	Var
155	STO 06	
156	+	MC
157	XEQ "DGR"	
158	FC? 55	
159	AVIEW	
160	CLA	
161	" DIST="	
162	RCL 05	
163	FRC	
164	1 E3	
165	*	Leg Distance
166	STO 08	
167	ARCL X	
168	"⊢ NM"	
169	XEQ "PR"	
170	ADV	
171	RCL 18	Present wind and alt.
172	STO 17	become the previous
173	RCL 13	wind and altitude.
174	STO 14	
175	FS? 05	Error trap: The alt.
176	FC? 07	must be the same if
177	GTO 00	the climbout and
178	RCL 43	descent point are in
179	INT	the same leg!
180	RCL IND 10	
181	INT	
182	X≠Y?	
183	CLX	
184	/	
185	LBL 00	
186	RCL 43	
187	FC? 05	
188	RCL IND 10	Alt.Var
189	ISG 10	
190	INT	
191	ABS	
192	STO 13	Present altitude

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

STEP/ LINE	KEY ENTRY	COMMENTS
193	RCL IND 10	
194	STO 18	Present wind
195	X<>Y	
196	RCL 14	Previous altitude
197	FS?C 06	
198	RTN	
199	X≠Y?	Altitude change?
200	XEQ "UPDN"	
201	RCL 05	
202	FRC	.DIS
203	FC? 07	Not Descent leg?
204	GTO 00	
205	RCL 32	Descent point
206	X>Y?	Enough time?
207	CF 07	- if not
208	RCL 05	True course
209	INT	
210	X<>Y	
211	+	CRS.DP
212	STO 32	
213	LASTX	
214	FIX 3	
215	RND	
216	ST- 05	remaining distance
217	CLX	
218	FC? 07	Error Trap:
219	LN	Not enough time for
220	GTO 01	descent!
221	LBL 00	
222	X=0?	Leg dist. flown?
223	GTO 02	
224	LBL 01	
225	RCL 24	Cruise TAS
226	STO 07	
227	RCL IND 10	Wind
228	FS?C 05	Climbout?
229	RCL 44	First Leg wind
230	XEQ "WC"	
231	RCL 29	Cruise F/F
232	*	
233	STO 11	Fuel
234	"LEVEL "	
235	FS? 55	
236	"FAT "	
237	ARCL 13	
238	XEQ "PR"	
239	XEQ "DSPLY"	
240	FS?C 07	
241	RTN	
242	LBL 02	
243	ISG 10	
244	GTO 20	
245	RCL 10	Present leg
246	INT	
247	LBL 21	Descent leg calculations
248	RCL 16	Last register used
249	1	
250	-	
251	1 E3	
252	/	
253	+	
254	STO 10	New pointer value
255	SF 07	Descent leg
256	XEQ 20	
257	RCL 25	Descent TAS
258	STO 07	
259	RCL 13	Highest altitude
260	STO 14	
261	RCL 21	Leg lowest altitude
262	STO 13	
263	RCL 32	Descent point
264	STO 05	
265	GTO 03	
266	LBL 04	
267	SF 06	Descent continued
268	XEQ 20	
269	LBL 03	
270	RCL 22	Descent wind
271	XEQ "WC"	
272	RCL 30	Descent F/F
273	*	
274	STO 11	
275	XEQ "DN"	
276	ISG 10	
277	GTO 04	
278	CLA	
279	ARCL IND 16	
280	"├ * "	
281	ARCL 33	
282	RCL 34	
283	X=0?	Terminal Waypoint?
284	GTO 00	
285	XEQ "PR"	
286	XEQ "WPD"	
287	FIX 0	
288	ADV	

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
289	♦LBL 00				
290	RCL 36	Gross weight			
291	"LANDING WT= "				
292	FS? 55				
293	GTO 00				
294	AVIEW				
295	CLA				
296	♦LBL 00				
297	ARCL X				
298	"⊢ LBS"				
299	XEQ "PR"				
300	6				
301	1/X				
302	RCL 35	Remaining fuel			
303	FC? 00	Fuel displayed in lbs?			
304	*				
305	RCL 29	Cruise F/F			
306	/				
307	X<0?	Fuel left?			
308	CLX				
309	STO 12	Remaining flight time			
310	"RESERVE "				
311	XEQ "TD"				
312	ADV				
313	"HAPPY FLYING"				
314	SF 12				
315	RCL 12				
316	.75	45 min. reserve			
317	X>Y?	sufficient fuel?			
318	"FUEL TOO LOW"				
319	BEEP				
320	AVIEW				
321	CF 12				
322	ADV				
323	END				

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	not used
01	Distance
02	Ground speed
03	Time
04	Magnetic heading
05	CRS.DIS
06	Variation
07	TAS
08	Leg Distance
09	Total Flying Time
10	Leg pointer
11	Fuel
12	scratch
13	Present Altitude
14	Previous Altitude
15	Total distance
16	Last Register (40+5N
17	Previous wind
18	Present wind
19	Departure elevation
20	Climb wind
21	Destination elevation / Descending Alt.
22	Descent wind
23	Climb TAS
24	Cruise TAS
25	Descent TAS
26	ROC
27	ROD
28	Climb F/F
29	Cruise F/F
30	Descent F/F
31	not used
32	Descent point
33	Destination WPIdentifier
34	Destination WPFix
35	Fuel weight
36	Gross weight
37	Departure WP Ident
38	Departure WP Fix
39	not used
40	Leg #1: Ident
41	WP Fix
42	CRS.DIS
43	Alt.var
44	Wind
45	Leg #2
etc.	
40+5N	Destination Identifier N is the number of legs

STATUS

SIZE 41+5N TOT. REG. ____ USER MODE

ENG ____ FIX ____ SCI ____ ON ____ OFF ____

DEG X RAD ____ GRAD ____

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05	C	Climbout	
06	C	Descent in 1st leg	
06	C	Continuing descent	
07	C	Descent point leg	

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

PROGRAM DESCRIPTION I

Program Title NAVIGATION

Contributor's Name

Address

City State/Country Zip Code

Program Description, Equations, Variables

This program computes course and distance from one fix to another along with intermediate waypoint fixes. Each leg data is displayed as the data is entered. The output consists of: Start and ending fix idents, MC, DIST, WP Ident and fix if the ending fix is a waypoint.

The program will calculate a waypoint over the first and the final fixes. Any prompt, except for the first one (FROM?) may be declined by resuming program execution with no input.

This program is similar to the AVNAV/AVFLY program, but of more use in the cockpit.

Necessary Accessories A card reader is recommended.

Operating Limits and Warnings The following subroutines are used: "NFIX", "CRS", "WP", "TWP", "PR", "WPD", "DGR", & "SYM".

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

A flight from the McGhee Tyson airport, Knoxville, Tn to the Muscle Shoals, Al airport. A printer is not used. The route will be from McGhee Tyson airport direct to Cowan intersection, with waypoints off of Hinch Mt. and Chattanooga vortacs, V54N to the Rocket vortac, V54 to the Muscle Shoals vortac, direct to the Muscle Shoals airport. The coordinates for the facilities are given under the Program Description II for the AVNAV Program. The coordinate data for the vortacs is recorded on a data card with a "V" added after the identifiers to differentiate them from an airport identifier.

SOLUTION:

Input	Function	Display	Comments
	XEQ NAV	FROM?	
TYS	R/S	CARD	Load card for next fix.
	Load data card	TYS LAT?	
35.4845	R/S	TYS LNG?	
83.5934	R/S	TYS VAR?	
1	R/S	TYS WP?	will use TYS Vortac
TYSV	R/S	TYS * WP:TYS	
	R/S	221.8, 7.3 NM	
	R/S	TYS TO?	need term. fix for primary leg
COWAN	R/S	CARD	
	R/S	COWAN	
	R/S	COWAN LAT?	Cowan is an intersection 277°,
	R/S	NEED FIX?	38 NM from CHA Vortac
CHAV	R/S	LEG MC?	
277	R/S	LEG DIST?	
38	R/S	TYS TO WP?	Intermediate fix for secondary leg
HCHV	R/S	TYS - WP:HCH	
	R/S	MC=245	Leg #1 Data
	R/S	DIST=44	
	R/S	WP:HCH	
	R/S	153.1, 19.3 NM	
	R/S	WP.HCH TO WP?	
CHAV	R/S	WP:HCH - WP:CHA	
	R/S	MC=243	Leg #2 Data
	R/S	DIST=29	
	R/S	WP:CHA	
	R/S	333.1, 21.1 NM	
	R/S	WP:CHA TO WP?	Don't need any more intermediate
	R/S	WP:CHA - COWAN	fixes.
	R/S	MC=243	Leg #3 Data
	R/S	DIST=32	
	R/S	COWAN TO?	
RQZV	R/S	COWAN TO WP?	No intermediate fix
	R/S	COWAN - RQZV	Leg #4 Data
	R/S	MC=246	

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Problem from the preceding page continued -

SOLUTION:

Input	Function	Display	Comments
	R/S	DIST=38	Leg #4 Data continued
	R/S	RQZV TO?	
MSLV	R/S	RQZV TO WP?	No intermediate fix.
	R/S	RQZV - MSLV	Leg #5 Data
	R/S	MC=261	
	R/S	DIST=43	
	R/S	MSLV TO?	
MSL	R/S	CARD	Need data
	R/S	MSL	
	R/S	MSL LAT?	
34.4443	R/S	MSL LNG?	
87.3637	R/S	MSL VAR?	
1	CHS, R/S	MSLV TO WP?	no intermediate fix
	R/S	MSLV-MSL	Leg #6 Data
	R/S	MC=291	
	R/S	DIST=6	
	R/S	MSL TO?	Terminate the flight
	R/S	MSL WP?	Do not need a terminal waypoint
	R/S	TYS TO MSL	Tota trip data
	R/S	T/DIST=192	
	R/S	0	End of program
	R/S	FROM?	Program starts over

Sample Problem (Sketch if Desired) Same as previous, but a printer is used:

PRINTOUT:

TYS * WP:TYS
221.8°, 7.3 NM

TYS to WP:HCH
MC=245°
DIST=44

LEG #1

WP:HCH
153.1°, 19.3 NM

WP:HCH to WP:CHA
MC=243°
DIST=29

LEG #2

WP:CHA
333.1°, 21.1 NM

WP:CHA to COWAN
MC=243°
DIST=32

LEG #3

COWAN to RQZV
MC=246°
DIST=38

LEG #4

RQZV to MSLV
MC=261°
DIST=43

LEG #5

MSLV to MSL
MC=291°
DIST=6

LEG #6

TYS TO MSL
T/DIST 192 NM

SOLUTION:

Input	Function	Display	Comments
	XEQ "NAV"	FROM?	
TYS	R/S	CARD	
	Load data card	TYS LAT?	35° 48' 45"
35.4845	R/S	TYS LNG?	83° 59' 34"
83.5934	R/S	TYS VAR?	1° W
1	R/S	TYS WP?	
TYSV	R/S	TYS TO?	TWP data printout
COWAN	R/S	CARD	
	R/S	COWAN	
	R/S	COWAN LAT?	
	R/S	NEED FIX?	
CHAV	R/S	LEG MC?	277° from CHA
277	R/S	LEG DIST?	38 DME
38	R/S	TYS TO WP?	
HCHV	R/S	WP:HCH TO WP?	Leg #1 data printout
CHAV	R/S	WP:CHA TO WP?	Leg #2 data printout
	R/S	COWAN TO?	Leg #3 data printout
RQZV	R/S	COWAN TO WP?	
	R/S	RQZV TO?	Leg #4 data printout
MSLV	R/S	RQZV TO WP?	
	R/S	MSLV TO?	Leg #5 data printout
MSL	R/S	CARD	
	R/S	MSL	
	R/S	MSL LAT?	34° 44' 43"
34.4443	R/S	MSL LNG	87° 36' 37"
87.3637	R/S	MSL VAR?	1° E
1	CHS	-1	
	R/S	MSLV WP?	
	R/S	MSL TO?	Leg #6 data printout
	R/S	MSL WP?	
	R/S	TYS TO MSL	Total trip printout
	R/S	FROM?	Program starts over

USER INSTRUCTIONS

SIZE: 35

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Size	35	XEQ SIZE	
2	Start program		XEQ NAV	FROM?
3	Input departure airport identifier	IDENT	R/S	see Step A
	From Step A (stp 2, 7, or skipped)			(ident) WP?
	From Step A (stp 11) skip to step 5			(ident) TO?
4	Input terminal waypoint fix identifier	IDENT	R/S	see Step A
	From Step A, Step A skipped			(ident) TO?
5	Input primary leg end fix identifier	IDENT	R/S	see Step A
	From Step A, Step A skipped			(ident) TO WP?
	Declined, skip to step 7		R/S	
6	Input waypoint identifier	IDENT	R/S	see Step A
	Input declined, skip to step 5		R/S	(ident) TO?
	From Step A, Step A skipped, repeat step 6			(ident) TO WP?
7	Prior primary fix input from:			
	Step A (stp 11) - program end!			
	Step A (stp 2, 11, or skipped)			(ident) WP?
8	Input terminal waypoint fix identifier		R/S	see Step A
	Input declined - program end!			
	From Step A, Step A skipped - program end!			
*	Steps for input of fix coordinates:			
A	If data already loaded from a prior card, skip Step A!			
1	If card reader not used, skip to step 4			CARD
2	Load data card			
	Data not on card skip to step 4			
	Data on the card			Return to the original step (ident)
3	Data card load declined		R/S	

USER INSTRUCTIONS

SIZE: 35

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
4	Resume program execution		R/S	(ident) LAT?
5	Input latitude	Degree	R/S	(ident) LNG?
	Input declined, skip to step 8		R/S	
6	Input longitude	Degree	R/S	(ident) VAR?
7	Input variation (+ W, - E)	Degree	(CHS) R/S	Return to the original step
8	Calculate coordinates			NEED FIX?
	Waypoint being calculated, skip to step 1			
9	Input reference fix (uses steps 1-7)	IDENT	R/S	FIX ~~LEG~~ MC?
	Input declined, uses prior fix for reference.		R/S	FIX ~~LEG~~ MC?
10	Input radial or heading from ref. fix	Degrees	R/S	FIX ~~LEG~~ DIST?
11	Input distance from ref. fix	NM	R/S	Return to the original step

LBL"NAV
END 379 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
	01♦LBL "NAV" DEG	
	02 CF 02	
	03 SF 21	
	04 CF 29	
	05 "FROM?"	
	06 SF 01	
	07 SF 23	
	08 XEQ "NFIX"	Departure Coord.
	09 CF 01	
	10 RCL 06	
	11 STO 14	Departure Ident
	12 CLX	
	13 STO 15	
	14 STO 32	
	15 32	
	16 FC?C 03	Terminal fix not a WP?
	17 XEQ "TWP"	Terminal waypoint
	18 RCL 14	
	19 STO 06	
	20 ADV	
	21 CLA	
	22 ARCL 14	
	23 "⊢ * "	
	24 ARCL 31	
	25 RCL 32	
	26 X=0?	TWP?
	27 GTO 20	
	28 XEQ "PR"	
	29 XEQ "WPD"	
FIX D →	30♦LBL 20	
	31 ADV	
	32 CLA	
	33 ARCL 06	
	34 ASTO 10	Primary leg's starting fix.
	35 "⊢ TO?"	
	36 CF 23	
	37 XEQ "NFIX"	
	38 FC? 23	
	39 GTO 22	
	40 XEQ "CRS"	
	41 STO 00	TC
	42 RCL 02	Distance
	43 RND	
	44 ST+ 15	Total distance
	45 STO 05	Primary leg distance
	46 RCL 11	Store primary leg's starting fix.
	47 STO 31	
	48 RCL 12	
	49 STO 32	
	50 RCL 13	
	51 STO 33	
	52 RCL 06	
	53 STO 34	
	54 0	
	55 STO 04	
	56 SF 02	
	57♦LBL 21	
	58 CLA	
	59 ARCL 10	
	60 "⊢ TO WP?"	
	61 CF 23	
	62 XEQ "NFIX"	
	63 FC? 23	Waypoint declined
	64 GTO 03	
	65 XEQ "CRS"	
	66 XEQ "WP"	
	67 FC?C 07	Waypoint completed?
	68 GTO 21	
	69 STO 13	
	70 "WP:"	
	71 ARCL 06	
	72 ASTO 06	
	73 RCL 12	"L"
	74 ENTER↑	
	75 X<> 04	
	76 XEQ 10	Data output
	77 RCL 11	
	78 STO 07	
	79 ADV	
	80 CLA	
	81 ARCL 06	
	82 XEQ "PR"	
	83 RCL 13	
	84 XEQ "WPD"	
	85 ADV	
	86 RCL 06	
	87 STO 10	Starting fix ident
	88 GTO 21	
	89♦LBL 03 FIX D	
	90 CF 02	
	91 RCL 34	
	92 STO 06	
	93 RCL 05	
	94 RCL 04	
	95 XEQ 10	Data output
	96 RCL 31	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'NAV
END 379 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
97	STO 07	Primary terminating fix
98	RCL 32	becomes the
99	STO 08	starting fix.
100	RCL 33	
101	STO 09	
102	GTO 20	
103	♦LBL 10	
104	-	Secondary leg distance
105	STO 12	
106	CLA	
107	ARCL 10	
108	FC? 55	
109	GTO 01	
110	ACA	
111	CLA	
112	SF 13	Leg Output
113	" TO "	
114	ACA	
115	CF 13	
116	CLA	
117	♦LBL 01	
118	FC? 55	
119	"⊢-"	
120	ARCL 06	
121	XEQ "PR"	
122	FIX 0	
123	"MC="	
124	RCL 00	TC
125	RCL 07	VAR'
126	+	MC
127	XEQ "DGR"	
128	XEQ "PR"	
129	"DIST="	
130	ARCL 12	
131	GTO "PR"	
132	♦LBL 22	
133	CLX	
134	STO 32	
135	32	
136	FC?C 03	
137	XEQ "TWP"	TWP
138	CLA	
139	ARCL 34	
140	"⊢ * "	
141	ARCL 31	
142	RCL 32	
143	X=0?	TWP?
144	GTO 05	
145	XEQ "PR"	
146	XEQ "WPD"	
147	ADV	
148	♦LBL 05	
149	SF 12	
150	CLA	
151	ARCL 14	
152	"⊢ TO "	Total Trip Output
153	ARCL 34	
154	AVIEW	
155	CF 12	
156	FIX 0	
157	"T/DIST "	
158	ARCL 15	
159	FS? 55	
160	"⊢ NM"	
161	XEQ "PR"	
162	ADV	
163	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS

00	True course
01	Scratch
02	Scratch
03	Scratch
04	WP Dist
05	Leg Dist
06	Identifier
07	VAR'
08	LNG'
09	LAT'
10	Starting fix ident
11	VAR
12	LNG
13	LAT
14	Departure airport ident
15	Total distance
16	
to	CARD DTA
30	
31	TWP ident / Leg Var
32	TWP fix / Leg LNG
33	Leg LAT
34	Leg ident

STATUS

SIZE 35 TOT. REG. _____ USER MODE

ENG _____ FIX _____ SCI _____ ON _____ OFF _____

DEG x RAD _____ GRAD _____

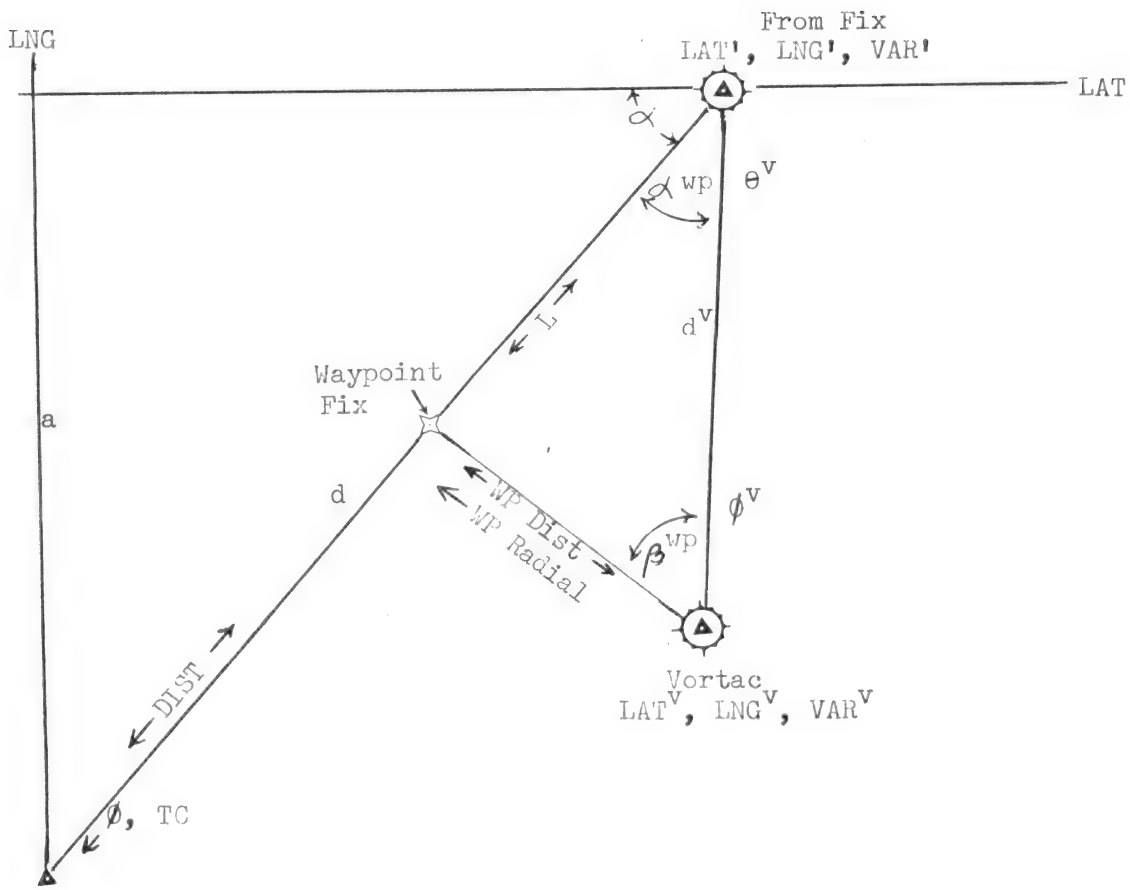
FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
01	C	Coord'	
02	C	Computing WP's	
03	C	Term. fix a WP	

ASSIGNMENTS

FUNCTION	KEY	FUNCTION	KEY

AVIGATION/RNAV
DIAGRAM & EQUATIONS



$$\text{WP Radial} = \theta^{v} \pm \beta^{wp} + \text{VAR}^{v}$$

$$\text{WP Dist} = 60 \ \text{Sin}^{-1}(\text{Sin} \ |\alpha^{wp}| \ \text{Sin} \ d^{v})$$

$$\text{LAT} = \text{LAT}' + \text{Sin}^{-1}(\text{Sin} \ d \ \text{Cos} \ \phi)$$

$$\text{LNG} = \text{LNG}' - \text{Sin}^{-1} \frac{(\text{Sin} \ d \ \text{Sin} \ \phi)}{\text{Cos} \ (\text{LAT} - \text{LAT}')/2}$$

$$\text{DIST} = 60 \ d$$

$$d = \text{Cos}^{-1}((\text{Sin LAT Sin LAT}' + \text{Cos LAT Cos LAT}' \ \text{Cos} \ (\text{LNG} - \text{LNG}'))$$

$$a = \text{Cos}^{-1}(\text{Sin LAT Sin LAT}' + \text{Cos LAT Cos LAT}')$$

$$\phi = \text{TC} = 270^{\circ} + \alpha \ \text{ or } \ 90^{\circ} - \alpha$$

$$\alpha = \frac{\text{Sin } a}{\text{Sin } d}$$

PROGRAM DESCRIPTION

Program Title Subroutines Navigation Fix and Intersection/Waypoint coordinates

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables "NFIX" prompts for: Facility alpha-numeric identifier; Data card if card reader is being used; and if data hasn't been read from a data card, prompts for the latitude, longitude, and magnetic variation. If latitude prompt is passed by and FL02 is clear, "I/WP" is used to prompt for data to calculate the coord. If FL02 is set the prgm starts at the beginning to give opportunity to check and correct data input.

"I/WP" calculates coordinates from given latitude and longitude. It prompts for fix coordinates using "NFIX and if none are given will use prior coordinates stored in R08, R09, & variation stored in R07. If FL01 is set the new coord. are stored in R07-R09, if clear then in R11-R13. If data is not entered than prgm cycles back to the beginning of "NFIX".

"I/WP" uses the following equations:

$$LAT = LAT' + \sin^{-1}(\sin d \cos \phi)$$

$$LNG = LNG' - (\sin^{-1}(\sin d \sin \phi))/\cos((LAT + LAT')/2)$$

d is dist/60; ϕ is MC-VAR' = TC (True Course)

NOTE: If Sub "I/WP" is used FL05 controls program flow if no data is entered. With FL05 cleared, Sub"NFIX" will prompt for data; if FL05 is set then the program will be returned to the main program.

Necessary Accessories Card reader is recommended, but optional.

Operating Limits and Warnings Destination must not be point of departure. West magnetic variations are positive, East magnetic variations are negative numbers.

LBL'NFIX
LBL'I/WP
END 291 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "NFIX"	Start
02	CF 05	
03	CF 06	
04	♦LBL 03	
05	13	
06	FS? 01	
07	9	
08	♦LBL 04	
09	STO 01	Data Pointer
10	♦LBL 05	
11	AON	
12	PROMPT	for Identifier
13	AOFF	
14	FC? 23	
15	RTN	
16	FC? 02	
17	CF 03	
18	ASTO 06	
19	16.03003	
20	STO 02	
21	STO 03	
22	XEQ 06	Search for data
23	FS?C 05	
24	RTN	
25	RCL 03	If coord. data not
26	STO 02	stored ask for data
27	SF 25	card if the card
28	AON	reader is used
29	RDTAX	
30	AOFF	
31	CF 25	
32	XEQ 06	Search for data again,
33	FS?C 05	if not found than
34	RTN	prompt for coord.
35	CF 22	
36	CLA	
37	ARCL 06	
38	"⊢ LAT?"	
39	PROMPT	
40	CLA	
41	ARCL 06	
42	FC? 22	No input, skip to
43	GTO 08	intersection/waypoint
44	HR	prompts
45	STO IND 01	
46	DSE 01	
47	CLA	
48	ARCL 06	
49	"⊢ LNG?"	
50	PROMPT	
51	HR	
52	STO IND 01	
53	DSE 01	
54	CLA	
55	ARCL 06	
56	"⊢ VAR?"	
57	PROMPT	
58	STO IND 01	
59	RTN	
60	♦LBL 06	Search for data
61	RCL 06	
62	RCL IND 02	
63	X=Y?	
64	GTO 07	
65	ISG 02	
66	GTO 06	
67	RTN	
68	♦LBL 07	
69	SF 05	Decode coordinate data
70	1	
71	ST+ 02	
72	RCL IND 02	
73	HR	
74	STO IND 01	
75	DSE 01	
76	1	
77	ST+ 02	
78	RCL IND 02	
79	FRC	
80	LASTX	
81	INT	
82	ABS	
83	1 E4	
84	/	
85	HR	
86	STO IND 01	
87	DSE 01	
88	RDN	
89	100	
90	*	
91	STO IND 01	
92	RTN	
93	♦LBL 08	
94	FC? 02	If FL02 & FL06 set
95	FS? 06	start over
96	GTO 05	
97	♦LBL "I/WP"	Calculates coord. for
98	RCL 07	intersection or
99	STO 11	waypoint.
100	RCL 08	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'NFIX
LBL'I/WP
END 291 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
101	STO 12	
102	RCL 09	
103	STO 13	
104	RCL 06	
105	STO 31	
106	SF 06	
107	CF 23	
108	13	
109	"NEED FIX?"	
110	XEQ 04	
111	CF 06	
112	RCL 31	
113	STO 06	
114	"FIX MC?"	
115	PROMPT	
116	CLA	
117	ARCL 06	
118	SF 23	
119	FC? 22	
120	GTO 03	
121	RCL 11	
122	FS? 01	
123	STO 07	
124	-	
125	STO 01	
126	"FIX DIST?"	
127	PROMPT	
128	60	
129	/	
130	SIN	Sin d
131	STO 02	
132	RCL 01	
133	SIN	Sin ϕ
134	*	
135	ASIN	
136	RCL 01	
137	COS	Cos ϕ
138	RCL 02	Sin d
139	*	
140	ASIN	
141	RCL 13	LAT'
142	+	
143	STO 13	LAT
144	FS? 01	
145	STO 09	
146	LASTX	LAT'
147	+	
148	2	
149	/	
150	COS	
151	/	
152	ST- 12	
153	RCL 12	LNG
154	FS? 01	
155	STO 08	
156	SF 03	
157	END	

DATA REGISTERS

01	Data Storage Pointer
02	Data Pointer
03	Counter value
06	Facility Identifier
07	VAR'
08	LNG'
09	LAT'
11	VAR
12	LNG
13	LAT
16	Magnetic card data
30	
31	Temporary Ident storage

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
01		Store coordinates in R07, R08, & R09	in Registers: R11, R12, & R13
02		Disables "NFIX" from using "I/WP"	
03		Indicates that the coordinates were calculated with "I/WP"	
05	C	Ident & coord. located & decoded.	
06	C	Fix coord. are being asked for by "I/WP"	
23	C		No input, RTN

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION

Program Title Subroutine Course and Distance

Contributor's Name

Address

City State/Country Zip Code

Program Description, Equations, Variables This subroutine calculates the great circle distance between two points defined by latitude and longitude coordinates and calculates the average true course.

Dist = 60 d, $d = \cos^{-1}((\sin LAT' \sin LAT + \cos LAT' \cos LAT \cos (LNG - LNG'))$

TC = 270 + α ; for West (FLO5 clr). TC = 90 - α ; for East (FLO5 set).

$\alpha = \sin^{-1}(\sin a / \sin d)$, α is negative if direction is Southerly.

where $a = \cos^{-1}(\sin LAT \sin LAT' + \cos LAT \cos LAT')$

Necessary Accessories

Operating Limits and Warnings Destination must not be point of departure.

North latitudes and West longitudes are positive and South latitudes and East longitudes are negative numbers.

LBL'CRS
END 67 BYTES
AVIGATION/RNAV 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "CRS"	
02	CF 05	
03	RCL 13	
04	SIN	
05	RCL 09	
06	SIN	
07	*	(Sin LAT Sin LAT')
08	STO 01	
09	RCL 13	
10	COS	
11	RCL 09	
12	COS	
13	*	(Cos LAT Cos LAT')
14	STO 02	
15	+	
16	ACOS	a
17	SIN	
18	RCL 13	
19	RCL 09	
20	-	+ Northerly direction
21	SIGN	− Southerly direction
22	*	
23	RCL 02	
24	RCL 12	
25	RCL 08	
26	-	
27	X<0?	
28	SF 05	set - Easterly
29	COS	clr - Westerly
30	*	
31	RCL 01	
32	+	
33	ACOS	d
34	SIN	
35	STO 01	
36	LASTX	
37	60	
38	*	Distance
39	STO 02	
40	RDN	
41	/	
42	ASIN	α
43	FS? 05	
44	CHS	
45	90	
46	+	
47	180	
48	FS?C 05	
49	CLX	
50	+	True Course
51	END	

DATA REGISTERS

01	Scratch
02	Distance
08	LNG'
09	LAT'
12	LNG
13	LAT

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05	C	Easterly course	Westerly course

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION

Program Title Subroutine Waypoint Fix

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables Calculates waypoint fix from the coordinates of a vortac which has a radial from it that is perpendicular to the course between the departure point and destination. It will reject any waypoint that falls behind the departure point, beyond the destination, or behind a prior waypoint.

$$\text{Waypoint Radial} = \left(\theta^V + \beta^{WP};\ \alpha^{WP} < 0 \quad \text{or} \quad \theta^V - \beta^{WP};\ \alpha^{WP} \geq 0\right) + VAR^V$$

where $\theta^V = \emptyset^V \pm 180^\circ$ and $\beta^{WP} = 90 - |\alpha^{WP}|$

$$\alpha^{WP} = \emptyset - \emptyset^V; \quad \emptyset \cong TC$$

$$\text{Waypoint Distance} = 60\ \text{Sin}^{-1}(\text{Sin}|\alpha^{WP}|\ \text{Sin}\ d^V)$$

$$\text{Distance from Departure point to the Waypoint} = 60\ \text{Sin}^{-1}(\text{Sin}\beta^{WP}\ \text{Sin}\ d^V) = L$$

Note: α^{WP} must be expressed as: $-180^\circ \leq \alpha^{WP} \leq 180^\circ$

Necessary Accessories

Operating Limits and Warnings Subroutine "CRS" must be run first in order to calculate the values for d^V and TC^V ($\emptyset^V$) between the departure point and the vortac. The departure point is defined as the beginning of the leg between two navigation fixes, This leg will be divided into smaller legs by the waypoints generated in the prgm.

LBL'WP
END 83 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "WP"	
02	FIX 0	
03	CF 05	
04	CF 07	
05	STO 02	$TC^V = \phi^V$
06	180	
07	+	θ^V
08	90	
09	RCL 00	ϕ
10	RCL 02	
11	-	α wp
12	1	
13	P-R	
14	R-P	
15	RDN	$-180^\circ \leq \alpha^{wp} \leq 180^\circ$
16	X<0?	
17	SF 05	
18	ABS	$\lvert\alpha$ wp$\rvert$
19	STO 02	
20	-	β wp
21	X<=0?	Waypoint behind depart.
22	RTN	fix?
23	STO 03	
24	FC?C 05	
25	CHS	
26	+	
27	RCL 11	VAR^V
28	+	Waypoint Radial
29	X<> 03	
30	SIN	
31	RCL 01	
32	*	
33	ASIN	
34	60	
35	*	
36	RND	
37	STO 12	Distance "L"
38	RCL 05	
39	X<=Y?	WP beyond destination
40	RTN	fix?
41	X<>Y	WP behind last WP?
42	RCL 04	
43	X>Y?	
44	RTN	
45	RCL 03	Waypoint Radial
46	360	
47	MOD	
48	10	
49	*	
50	RND	
51	RCL 02	$\lvert\alpha^{WP}\rvert$
52	SIN	
53	RCL 01	Sin d^V
54	*	
55	ASIN	Waypoint Distance
56	.06	
57	*	
58	+	Waypoint fix (Rad.Dist)
59	SF 07	
60	END	

DATA REGISTERS

"X"	O^V from "CRS"
00	TC
01	SIN d^V from "CRS"
02	$\lvert\alpha^{WP}\rvert$
03	WP Radial
04	Cumulative WP distance in leg
05	Distance in leg
11	VAR^V
12	Distance "L"

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05	C	$\alpha^{WP} < 0$	$\alpha^{WP} \geq 0$
07	C	WP is valid	WP is invalid

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION

Program Title Subroutine Terminal Waypoint

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables Calculates a radial and distance from a vortac to a facility and stores them together in a specified data register; stores the identifier in the preceding data register. This provides a waypoint over an airport.

The coordinates of the terminal facility must be in R08 & R09, the terminal identifier in R06, and the data register number in the X Register prior to running the subroutine.

Necessary Accessories Subroutines "NFIX" & "CRS"

Operating Limits and Warnings

LBL'TWP
END 74 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "TWP"	
02	FIX 0	
03	STO 05	Data register pointer
04	CLA	
05	ARCL 06	
06	"⊢ WP?"	Prompt for Vortac
07	SF 02	Disable "I/WP"
08	CF 23	
09	XEQ "NFIX"	
10	CF 02	
11	FC? 23	WP declined?
12	RTN	
13	XEQ "CRS"	
14	180	
15	+	
16	RCL 11	VAR^V
17	+	
18	360	
19	MOD	
20	10	
21	*	
22	RND	WP radial
23	RCL 02	WP distance
24	1 E3	
25	/	
26	+	WP Fix
27	STO IND 05	
28	DSE 05	
29	"WP:"	
30	ARCL 06	WP Ident
31	ASTO IND 05	
32	END	

DATA REGISTERS

02	Distance, calculated by "CRS"
05	Data storage pointer
06	Terminal identifier
07	VAR'
08	LNG'
09	LAT'
11	VAR_V
12	LNG_V
13	LAT_V

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
02	S	Disables "I/WP"	
23	C	Term. WP desired	Term. WP declined

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION

Program Title Subroutine Winds Aloft

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables This subroutine prompts for the forcast winds aloft above and below the flight altitude and interpolates the wind for the flight altitude. Winds aloft will be prompted for in thousands of feet in the following increments: 3, 6, 9, 12, 18, 24, 30, 34, 39, 45, & 53. The flight altitude must be stored in the X Register prior to subroutine execution. The interpolated wind will be in the X Register upon completion of the subroutine, unless input was declined and than zero will be in the X Register.

Winds must be entered in the following format: DIR.VEL, where DIR is wind direction in degrees true, and VEL is the wind velocity in knots. Example: if the wind is reported as "2415" the wind is 240°, 15 kts and would be entered as 240.015.

Necessary Accessories

Operating Limits and Warnings If departure airport is above 3000' and the flight altitude is relatively low; than the lower wind prompted for could be below the airport elevation. In that case it is recommended that the next higher forcasted winds be entered and when the higher wind is prompted for decline entry. The output will be the same as the wind entered.

LBL'WIND
END 164 BYTES
AVIGATION/RNAV 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "WIND"	
02	FIX 0	
03	CF 05	
04	CF 22	
05	1 E3	
06	/	
07	30	
08	X<Y?	Alt. above FL 300?
09	GTO 03	
10	X<>Y	
11	12	
12	X<>Y	
13	X>Y?	Alt. above 12,000'?
14	SF 05	
15	3	
16	ENTER↑	
17	FC?C 05	
18	CLX	
19	+	Alt. increment
20	STO 02	
21	X>Y?	Alt. < 3,000'?
22	SF 05	
23	/	
24	FRC	Interpolation value
25	STO 03	
26	X=0?	Alt. same as forcast
27	SF 05	wind?
28	CLX	
29	STO 01	
30	LASTX	
31	INT	
32	X=0?	
33	1	
34	RCL 02	
35	*	lower wind level
36	LBL 01	
37	FS?C 05	
38	GTO 04	
39	ST+ 02	
40	XEQ 04	prompt for lower wind
41	FC? 22	
42	RTN	
43	STO 01	
44	RCL 02	
45	XEQ 04	prompt for higher wind
46	STO 02	
47	INT	
48	RCL 01	
49	INT	
50	-	
51	LASTX	
52	X<>Y	
53	1	
54	P-R	
55	R-P	
56	RDN	
57	RCL 03	Interpolation of the
58	*	
59	+	Wind Direction
60	RND	
61	360	&
62	MOD	
63	RCL 02	
64	FRC	Wind Velocity
65	RCL 01	
66	FRC	
67	-	
68	LASTX	
69	X<>Y	
70	RCL 03	
71	*	
72	+	
73	+	
74	RTN	
75	LBL 02	
76	/	Interpolation value
77	STO 03	(higher winds)
78	X=0?	
79	SF 05	
80	CLX	
81	X<> 01	
82	GTO 01	
83	LBL 03	
84	STO 01	
85	-	
86	4	
87	STO 02	
88	X>Y?	Alt. < FL 340?
89	GTO 02	
90	ST+ 01	
91	-	
92	5	
93	STO 02	
94	X>Y?	Alt. < FL 390?
95	GTO 02	
96	ST+ 01	

LBL'WIND
END 164 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
97	-	
98	6	
99	STO 02	
100	X>Y?	Alt. < FL 450?
101	GTO 02	
102	ST+ 01	
103	-	
104	8	
105	STO 02	
106	X>Y?	Alt. <FL 530?
107	GTO 02	
108	0	
109	X<> 01	
110	+	
111	*LBL 04	
112	"WA"	Prompt for Wind
113	ARCL X	
114	"F?"	
115	RCL 01	
116	PROMPT	
117	END	

DATA REGISTERS

01	Lower wind level / lower wind value
02	Altitude increment / higher wind value
03	interpolation value

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05	C	Alt > 12,000'	Alt < 12,000'
05	C	Prompt for lower wind only.	
22	C	Wind entered	Entry declined

LBL'PRF
LBL'PP
AVIGATION/RNAV

PROGRAM DESCRIPTION

Program Title Subroutine for Aircraft Performance

Contributor's Name

Address

City State/Country Zip Code

Program Description, Equations, Variables Prompts and stores aircraft performance figures into registers 23 thru 30. If input is declined the program will reprompt until data is entered; except when fuel flow figures are requested, than a zero will be entered.

When a card reader is used the program will request a data card if the first prompt is declined. If a data card isn't read; than the program will give oppourtunity to to record the data, not only in the allocated registers, but also by writting the data on a card. If the first prompt (Climb TAS?) is declined again the cycle will start over.

Label "PR" allows the performance figures for an aircraft to be recorded on a magnetic card without having to use the entire subroutine.

Necessary Accessories Card reader is recommended, but optional.

Operating Limits and Warnings The program will not except an entry of zero for any of of the airspeeds, R.O.C., or R.O.D.

LBL'PRF
LBL'RP
END 224 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "PRF"	
02	CF 05	
03	♦LBL 01	
04	23.03	Counter value
05	STO 01	
06	CLX	
07	"CLIMB TAS?"	
08	PROMPT	
09	STO 23	
10	X≠0?	Data entered?
11	GTO 02	
12	FS? 06	Using "PR"?
13	GTO 01	
14	FS?C 05	Going to record?
15	RTN	
16	RCL 01	
17	SF 25	
18	"RECORD PERF"	
19	AON	
20	RDTAX	
21	AOFF	
22	FC?C 25	Using card reader?
23	GTO 01	
24	RCL 23	
25	X≠0?	Data entered?
26	RTN	
27	♦LBL 06	
28	SF 05	
29	XEQ 01	Prompt data for card
30	FC?C 05	Data entered?
31	GTO 01	
32	CF 06	
33	RCL 01	
34	WDTAX	
35	RTN	
36	♦LBL "RP"	
37	SF 06	
38	GTO 06	
39	♦LBL 02	
40	CF 22	
41	"CRUISE TAS?"	
42	PROMPT	
43	FS?C 22	
44	X=0?	
45	GTO 02	
46	STO 24	
47	♦LBL 03	
48	"DESCENT TAS?"	
49	PROMPT	
50	FS?C 22	
51	X=0?	
52	GTO 03	
53	STO 25	
54	♦LBL 04	
55	"R.O.C.?"	
56	PROMPT	
57	FS?C 22	
58	X=0?	
59	GTO 04	
60	STO 26	
61	♦LBL 05	
62	"R.O.D.?"	
63	PROMPT	
64	FS? 22	
65	X=0?	
66	GTO 05	
67	STO 27	
68	CLX	
69	"CLIMB F/F?"	
70	PROMPT	
71	STO 28	
72	CLX	
73	"CRUISE F/F?"	
74	PROMPT	
75	STO 29	
76	CLX	
77	"DESCENT F/F?"	
78	PROMPT	
79	STO 30	
80	END	

DATA REGISTERS

01	counter value	27	rate of descent
23	climb TAS	28	climb fuel flow
24	cruise TAS	29	cruise fuel flow
25	descent TAS	30	descent fuel flow
26	rate of climb		

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05	C	data to be recorded	
06		disable data card	request

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION

Program Title Subroutine Climb / Descent

Contributor's Name

Address

City State/Country Zip Code

Program Description, Equations, Variables If the previous altitude flown is entered into the Y Register and the altitude desired in the X Register the subroutine will detect if a climb or descent is required, determine the average wind from the winds of the previous and present legs, determine how much time is needed, and determine how much time is available.

Climb or Descent with the starting and ending altitudes will be given; then the Display subroutine is used to give the flight data during the altitude change. If a printer is being used the data will be printed, if not than it will be displayed. If the data is being displayed the program execution will be halted as each line is displayed.

If FLO5 is set prior to subroutine execution the flight data will be calculated with the wind data stored in R20 instead of averaging the leg winds.

Necessary Accessories Subroutines "WC" & "DSPLY". Printer is recommended, but optional.

Operating Limits and Warnings TAS and vertical speed must not equal zero.

LBL'UPDN
LBL'DN
END 192 BYTES
AVIGATION/RNAV 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "UPDN"	
02	FIX 0	
03	CF 06	
04	-	altitude change
05	STO 11	
06	X>0?	Climb?
07	SF 06	
08	RCL 26	ROC
09	FC? 06	Descent?
10	RCL 27	ROD
11	STO 12	vertical speed
12	RCL 25	Descent TAS
13	FS? 06	Climb?
14	RCL 23	Climb TAS
15	STO 07	TAS
16	RCL 20	Special wind data
17	FS? 05	Special wind?
18	GTO 00	
19	RCL 18	
20	INT	present wind direction
21	RCL 17	
22	INT	previous wind direction
23	-	
24	LASTX	
25	X<>Y	
26	1	
27	P-R	
28	R-P	
29	RDN	
30	2	
31	/	
32	+	
33	RND	
34	360	
35	MOD	Average wind direction
36	RCL 18	
37	FRC	present wind velocity
38	RCL 17	
39	FRC	previous wind velocity
40	-	
41	LASTX	
42	X<>Y	
43	2	
44	/	
45	+	Average wind velocity
46	+	Average wind
47	♦LBL 00	
48	XEQ "WC"	
49	RCL 11	Alt. change
50	ABS	
51	RCL 12	rate of change
52	/	
53	60	
54	/	total time needed
55	X>Y?	not enough time?
56	GTO 00	
57	STO 03	time taken to change alt.
58	RCL 02	ground speed
59	*	
60	RND	distance traveled during
61	STO 01	the climb/descent
62	1 E3	
63	/	
64	GTO 01	
65	♦LBL 00	
66	X<>Y	available time
67	60	
68	*	
69	RCL 12	vertical speed
70	*	altitude change
71	FC? 06	Descent?
72	CHS	
73	RCL 14	starting altitude
74	+	
75	STO 13	ending altitude
76	RCL 05	CRS.DIST
77	FRC	.DIST
78	♦LBL 01	
79	ST- 05	subtract distance travel-
80	RCL 30	descent f/f ed
81	FS? 06	Climb?
82	RCL 28	climb f/f
83	RCL 03	Time
84	*	
85	STO 11	Fuel used
86	"CLIMB"	
87	♦LBL "DN"	
88	FC?C 06	Descent?
89	"DESCENT"	
90	FC? 55	
91	GTO 02	
92	ACA	
93	RCL 14	Display or Printout
94	ACX	
95	1	
96	SKPCHR	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'UPDN
LBL'DN
END 192 BYTES
AVIGATION/RNAV 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
97	125	
98	ACCHR	
99	RCL 17	
100	ACX	
101	PRBUF	
102	GTO 03	Display or
103	LBL 02	
104	AVIEW	Printout
105	CLA	
106	ARCL 14	
107	"⊢-"	
108	ARCL 13	
109	AVIEW	
110	LBL 03	
111	GTO "DSPLY"	
112	END	

DATA REGISTERS

01	Distance
02	Ground speed
03	Time
05	True course + Dist/1000
07	TAS
11	Altitude change / Fuel used
12	Vertical speed
13	Ending altitude
14	Starting altitude
17	Previous wind aloft
18	Present wind aloft
20	Special wind aloft
23	Climb TAS
25	Descent TAS
26	Rate of Climb
27	Rate of Descent
28	Climb Fuel Flow
30	Descent Fuel Flow

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
05		Recall winds in R20	
06	C	Climbing	Descending
55		Using Printer	No Printer

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION

Program Title Subroutine Wind Correction

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables The subroutine calculates Wind Correction Angle (WCA), Magnetic Heading (MH), and ground speed (GS) from the true airspeed (TAS), true course (TC), and the wind aloft located in the X register at the beginning of the subroutine. From the GS and leg distance the time is calculated. The subroutine is considerably shortened by the use of Polar - Rectangular conversion.

Definitions: Wind is given traditionaly as a true direction and 180° out of phase.

W° is the wind direction and W^{V} is the wind velocity.

The polar coordinates (θ, r): $\theta = W^{\circ} - TC$ and $r = W^{V}/TAS$

Formulas: $WCA = \sin^{-1}(W^{V}\sin(W^{\circ}-TC)/TAS)$; $MH = TC + WCA + VAR$

$GS = TAS \cos WCA - W^{V} \cos \theta$ $\quad$ $Time = DIST/GS$

Derivations: $Y = r \sin \theta = W^{V}\sin(W^{\circ}-TC)/TAS$; $WCA = \sin^{-1} Y$

$A = \cos WCA - r \cos \theta = \cos WCA - W^{V}\cos(W^{\circ}-TC)/TAS$

$GS = TAS \times A = TAS \cos WCA - W^{V} \cos \theta$

Polar - Rectangular conversion converts θ and r to X and Y where:

$Y = r \sin \theta$ and $X = r \cos \theta$.

Necessary Accessories

Operating Limits and Warnings TAS must not equal zero.

LBL'WC
END 52 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "WC"	
02	FIX 0	
03	FRC	$W^V/1000$
04	LASTX	
05	INT	W^O
06	RCL 05	
07	INT	TC
08	-	θ
09	X<>Y	
10	1 E3	
11	*	W^V
12	RCL 07	TAS
13	/	r
14	P-R	r Cos θ
15	RDN	r Sin θ
16	ASIN	WCA
17	COS	
18	R↑	r Cos θ
19	LASTX	WCA
20	RCL 05	
21	INT	TC
22	+	
23	RCL 06	VAR
24	+	
25	RND	MH
26	STO 04	
27	RDN	
28	-	A
29	RCL 07	TAS
30	*	
31	STO 02	GS
32	RCL 05	
33	FRC	
34	1 E3	
35	*	
36	STO 01	DIST
37	RCL 02	
38	/	
39	STO 03	Time
40	END	

DATA REGISTERS

01	Distance
02	Ground speed
03	Time
04	MH
05	CRS.DIS
06	VAR
07	TAS

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION

Program Title Display Subroutines

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables "DSPLY" displays magnetic heading as HDG, DIST (only if less than the leg distance), Remaining distance as REM DIST if it isn't zero, fuel used and remaining fuel if there is a fuel amount stored in R35, Time, and Total time as T/TIME.

"TD" displays time in HR:MM:SS format. The alpha register must be cleared prior to execution or contain a prefix for "TIME".

"WPD" decodes waypoint fix data for display.

"PR" prints the data if the printer is used; if not, will display it and halt execution.

"DGR" displays direction in degrees in proper format. Displays 0° as 360°.

"SYM" generates the degree symbol (^{o}).

Necessary Accessories The printer is recommended, but optional.

Operating Limits and Warnings If fuel and gross weight are not stored prior to program execution, fuel data will not be displayed if R35 is zero or less. If R36 is zero the fuel weight used will be totaled as a negative number.

LBL'DSPLY
LBL'TD
LBL'PR
LBL'WPD
LBL'DGR
LBL'SYM

END 329 BYTES

AVIGATION/RNAV

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "DSPLY"	
02	FIX 0	
03	"HDG="	
04	RCL 04	
05	XEQ "DGR"	
06	XEQ "PR"	
07	"GS="	
08	ARCL 02	
09	XEQ "PR"	
10	"DIST="	
11	ARCL 01	
12	RCL 08	
13	RCL 01	
14	X≠Y?	
15	XEQ "PR"	
16	ST- 15	
17	"REM DIST="	
18	ARCL 15	
19	RCL 15	
20	RND	
21	X>0?	
22	XEQ "PR"	
23	FC? 00	
24	FIX 1	
25	"FUEL="	
26	ARCL 11	
27	1	
28	RCL 11	
29	FC? 00	
30	6	
31	*	
32	RND	
33	ST- 36	
34	ST- 35	
35	RCL 35	
36	X<=0?	
37	GTO 00	
38	XEQ "PR"	
39	"REM FUEL="	
40	6	
41	1/X	
42	RCL 35	
43	FC? 00	
44	*	
45	ARCL X	
46	XEQ "PR"	
47	♦LBL 00	
48	FIX 4	
49	RCL 03	
50	HMS	
51	RND	
52	HR	
53	STO 03	
54	ST+ 09	
55	CLA	
56	XEQ "TD"	
57	"T/"	
58	RCL 03	
59	RCL 09	
60	X≠Y?	
61	XEQ "TD"	
62	ADV	
63	RTN	
64	♦LBL "TD"	
65	CF 29	
66	FIX 0	
67	HMS	
68	INT	
69	"⊢TIME="	
70	ARCL X	
71	10	
72	XEQ 10	
73	X<>Y	
74	XEQ 10	
75	♦LBL "PR"	
76	FC? 55	
77	GTO 00	
78	ACA	
79	PRBUF	
80	RTN	
81	♦LBL 00	
82	AVIEW	
83	RTN	
84	♦LBL 10	
85	"⊢:"	
86	LASTX	
87	FRC	
88	100	
89	*	
90	X<Y?	
91	"⊢0"	
92	INT	
93	ARCL X	
94	RTN	
95	♦LBL "WPD"	
96	CLA	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'DSPLY
LBL'TD
LBL'PR
LBL'WPD
LBL'DGR
LBL'SYM

END 329 BYTES
AVIGATION/RNAV

PROGRAM LISTING

41C

STEP/ LINE	KEY ENTRY	COMMENTS
97	STO 11	
98	FIX 1	
99	INT	
100	10	
101	/	
102	XEQ "DGR"	
103	"⊢, "	
104	RCL 11	
105	FRC	
106	1 E3	
107	*	
108	ARCL X	
109	"⊢ NM"	
110	GTO "PR"	
111	LBL "DGR"	
112	360	
113	MOD	
114	X≠0?	
115	GTO 00	
116	LASTX	
117	+	
118	LBL 00	
119	100	
120	X>Y?	
121	"⊢0"	
122	SQRT	
123	X>Y?	
124	"⊢0"	
125	ARCL Y	
126	FC? 55	
127	RTN	
128	LBL "SYM"	
129	ACA	
130	0	
131	ENTER↑	
132	BLDSPEC	
133	6	
134	BLDSPEC	
135	9	
136	BLDSPEC	
137	9	
138	BLDSPEC	
139	9	
140	BLDSPEC	
141	6	
142	BLDSPEC	
143	ACSPEC	
144	CLA	

STEP/ LINE	KEY ENTRY	COMMENTS
	NSCLX	
145	END	

DATA REGISTERS

01	Distance
02	Ground speed
03	Time
04	Magnetic heading
08	Leg distance
09	Total time
11	Fuel used / WP Fix
15	Total Distance
35	Fuel weight
36	Gross weight

FLAGS

#	INIT S/C	SET INDICATES	CLEAR INDICATES
00		Fuel is in LBS	Fuel is in US Gal.
55		Printer being used	Printer not used

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION I

Program Title Data Record

Contributor's Name

Address

City State/Country Zip Code

Program Description, Equations, Variables This program prompts for navigation fix data, encodes it, and writes it on a magnetic card. The recorded data includes the facility identifier, latitude & longitude coordinates, and the magnetic variation. Each facility takes 3 data registers, so a total of five facilities may be recorded on each track. The data, after it is input may be reviewed for correctness and changed if needed. After the data is input and after it has been viewed, the program prompts to write it on a card. If a card track is loaded by simply inserting it into the card reader, that data ~~will~~ MAY ~~can~~ be viewed. Anytime the program prompts for the ident, if input is declined, the program will proceed to view the contents.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS	STATUS
00 to 15 Facility data 17 Counter value 18 Identifier	SIZE 18 TOT. REG. USER MODE ENG FIX SCI ON OFF DEG RAD GRAD

Necessary Accessories Card Reader

Operating Limits and Warnings ~~If the viewing is terminated while viewing the variation the variation data will be lost from that data register. This isn't important as~~ IF the data ~~will~~ HAS already ~~have been recorded, unless "DR" is being used in a master program.~~ Terminating ~~the viewing anywhere else will not change the data in the registers.~~

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Write the Identifiers, coordinates, and magnetic variation of the following facilities on a magnetic card. Add the letter "V" to the end of each identifier to show that it is a vortac and not an airport.

1.	Knoxville Vortac:	TYS	35° 54' 17"N	83° 53' 41"W	1°W
2.	Hinch Mt. Vortac:	HCH	35° 46' 51"N	84° 58' 43"W	1°E
3.	Chattanooga Vortac:	CHA	34° 57' 40"N	85° 09' 12"W	1°E
4.	Rocket Vortac:	RQZ	34° 47' 49"N	86° 38' 02"W	2°E
5.	Muscle Shoals Vortac:	MSL	34° 42' 24"N	87° 29' 29"W	1°E

* It is recommended that the data be viewed after being written on a data card, whether it is the first time the data is written or after corrections have been made, to insure accuracy.

SOLUTION:

Input	Function	Display	Comments
	XEQ "DR"	IDENT?	If input declined will view all 5 data groups.
TYSV	R/S	TYSV LAT?	
35.5341	R/S	TYSV LNG?	Mistake made!
83.5341	R/S	TYSV VAR?	
1	R/S	IDENT?	If input declined will view next 4 data groups.
HCHV	R/S	HCHV LAT?	
35.4651	R/S	HCHV LNG?	
84.0912	R/S	HCHV VAR?	Monday morning, another mistake!
1	CHS	-1	
	R/S	IDENT?	Input declined, will view 3 groups
CHAV	R/S	CHAV LAT?	
34.5740	R/S	CHAV LNG?	
85.0912	R/S	CHAV VAR?	
1	CHS, R/S	IDENT?	-1 entered for E variation
RQZV	R/S	RQZV LAT?	
34.4749	R/S	RQZV LNG?	
86.3802	R/S	RQZV VAR?	
2	CHS, R/S	IDENT?	
MSLV	R/S	MSLV LAT?	
34.4224	R/S	MSLV LNG?	
87.2929	R/S	MSLV VAR?	
1	CHS, R/S	RDY 01 OF 01	Ready to write data card
	Insert Card	TYSV	View - correct?
	R/S	TYSV = 35.5341	Incorrect LAT, correct it!
35.5417	R/S	TYSV = 83.5341	View LNG
	R/S	TYSV = 1.0	View VAR
	R/S	HCHV	View Ident
	R/S	HCHV = 35.4651	View LAT
	R/S	HCHV = 84.0912	View LNG, incorrect - correct it!
84.5843	R/S	HCHV = -1.0	View VAR
	R/S	CHAV	
11 steps viewed	R/S	(11 steps viewed and found correct)	
		MSLV = -1.0	
	R/S	RDY 01 OF 01	Ready to rewrite data card with corrections.
	Insert Card	View started over*	

USER INSTRUCTIONS

SIZE: 18

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	Size	18	XEQ "SIZE"	
2	Start program		XEQ "DR"	IDENT?
3	Input identifier (6 characters or less)	Ident	R/S	(ident) LAT?
	Input declined, skip to step 8		R/S	(ident)
4	Input Latitude	DD.MMSS	R/S	(ident) LNG?
5	Input Longitude	DD.MMSS	R/S	(ident) VAR?
6	Input magnetic variation (-W, -E)	DD	(CHS), R/S	
	Less than 5 data groups input, repeat steps 3 thru 6			IDENT?
	Five Nav fix data groups are input			RDY 01 OF 01
7	Write data card	Insert Card		(ident)
8	View identifier, (correct if necessary)	(Ident)	R/S	(ident) = (lat)
9	View latitude, (correct if necessary)	(lat)	R/S	(ident) = (lng)
10	View longitude, (correct if necessary)	(lng)	R/S	(ident) = (var)
11	View magnetic variation, (correct if)	(var)	R/S	
	Repeat steps 8 thru 8 thru 11 until...	see note		(ident)
	Viewing and corrections completed			RDY 01 OF 01
12	If corrections were needed, skip to step 7			
	If no corrections were needed, terminate prgm		R/S	

* NOTE: All five nav fix data groups will be viewed, unless input was declined in step 3 - then that group and remaining groups will be viewed.

LBL'DR
END 188 BYTES
AVIGATION/RNAV 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	*LBL "DR"	
02	.014	Counter value
03	STO 15	
04	*LBL 01	
05	CF 23	
06	"IDENT?"	
07	AON	
08	PROMPT	
09	AOFF	
10	FC?C 23	Input declined?
11	GTO 03	start viewing data
12	ASTO 16	Store Ident
13	ASTO IND 15	
14	ISG 15	
15	CLA	
16	ARCL 16	
17	"⊢ LAT?"	
18	PROMPT	
19	STO IND 15	
20	ISG 15	
21	CLA	
22	ARCL 16	
23	"⊢ LNG?"	
24	PROMPT	
25	1 E4	
26	*	
27	CLA	
28	ARCL 16	Code LNG.VAR
29	"⊢ VAR?"	
30	PROMPT	
31	SIGN	
32	X<>Y	
33	LASTX	
34	ABS	
35	100	
36	/	
37	+	
38	*	
39	STO IND 15	
40	ISG 15	
41	GTO 01	
42	*LBL 02	
43	.014	
44	STO 15	
45	WDTAX	Write data card
46	*LBL 03	
47	CLA	
48	AON	
49	ARCL IND 15	
50	PROMPT	View Identifier/
51	AOFF	correct & store
52	ASTO 16	
53	ASTO IND 15	
54	ISG 15	
55	FIX 4	
56	RCL IND 15	
57	CLA	
58	ARCL 16	
59	"⊢="	
60	ARCL X	
61	PROMPT	View Lat/ correct
62	STO IND 15	& store
63	ISG 15	
64	RCL IND 15	
65	INT	
66	ABS	
67	1 E4	*
68	/	
69	CLA	
70	ARCL 16	
71	"⊢="	
72	ARCL X	
73	PROMPT	View Lng/ correct
74	1 E4	& store
75	*	
76	X<> IND 15	
77	FIX 1	
78	FRC	
79	100	
80	*	
81	CLA	
82	ARCL 16	
83	"⊢="	
84	ARCL X	
85	PROMPT	View Var/ correct
86	100	& store
87	/	
88	ABS	
89	ST+ IND 15	
90	LASTX	
91	SIGN	
92	ST* IND 15	
93	ISG 15	
94	GTO 03	
95	GTO 02	Write data card
96	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION I

Program Title Mach Number and True Airspeed

Contributor's Name

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables

This program converts calibrated airspeed (CAS) to mach number (M) and true airspeed (TAS). Inputs required are pressure altitude (PALT), aircraft recovery coefficient (C_T) and indicated air temperature (IAT). Values for recovery coefficient vary from 0.6 to 1.0, but 0.8 is a good value for most aircraft.

The formulas used are less accurate for mach numbers above 1.0 (i.e., supersonic flight).

$$\text{Pressure ratio}\left(\frac{P}{P_o}\right) = \left[\frac{518.67 - 3.566 \times .10^{-3}\ \text{PALT}}{518.67}\right]^{5.2563}$$

$$M^2 = 5\left[\left(\frac{P_0}{P}\left\{\left[1 + 0.2\left(\frac{\text{CAS}}{661.5}\right)^2\right]^{3.5} - 1\right\} + 1\right)^{0.2857} - 1\right]$$

$$\text{TAS} = 38.96M\sqrt{(\text{IAT} + 273)\left[C_T\left(\frac{1}{(1 + 0.2\,M^2)} - 1\right) + 1\right]}$$

SIZE: 008

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	To compute mach number and true airspeed		XEQ TA	PALT= (ALT)?
2	Input pressure altitude.	PALT, ft.	R/S	CAS= (CAS)?
3	Input calibrated airspeed.	CAS, kt.	R/S	CT= (CT)?
4	Input aircraft recovery coefficient.	C_T	R/S	IAT= (IAT)?
5	Input indicated air temperature.	IAT, °C	R/S	MACH M TAS= (TAS)

Necessary Accessories

Operating Limits and Warnings

LBL"TAS
END 177 BYTES
AVIGATION/RNAV

PROGRAM LISTING

■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "TAS"	
02	SF 21	
03	FIX 0	
04	RCL 01	
05	"PALT="	
06	ARCL X	
07	"⊢?"	
08	PROMPT	
09	STO 01	
10	RCL 02	
11	"CAS="	
12	ARCL X	
13	"⊢?"	
14	PROMPT	
15	STO 02	
16	RCL 03	
17	"IAT="	
18	ARCL X	
19	"⊢?"	
20	PROMPT	
21	STO 03	
22	FIX 1	
23	RCL 04	
24	"CT="	
25	ARCL X	
26	"⊢?"	
27	PROMPT	
28	STO 04	
29	RCL 01	
30	-3566 E-6	
31	*	
32	518.67	
33	+	
34	LASTX	
35	/	
36	5.2563	
37	Y↑X	
38	STO 05	
39	RCL 02	
40	661.5	
41	/	
42	X↑2	
43	5	
44	/	
45	1	
46	+	
47	3.5	
48	Y↑X	
49	1	
50	-	
51	RCL 05	
52	/	
53	1	
54	+	
55	3.5	
56	1/X	
57	Y↑X	
58	1	
59	-	
60	5	
61	*	
62	SQRT	
63	STO 06	
64	FIX 2	
65	"MACH "	
66	ARCL X	
67	AVIEW	
68	RCL 06	
69	X↑2	
70	5	
71	/	
72	1	
73	+	
74	1/X	
75	1	
76	-	
77	RCL 04	
78	*	
79	1	
80	+	
81	273	
82	RCL 03	
83	+	
84	*	
85	SQRT	
86	RCL 06	
87	*	
88	38.96	
89	*	
90	FIX 0	
91	"TAS="	
92	ARCL X	
93	AVIEW	
94	END	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

PROGRAM DESCRIPTION I

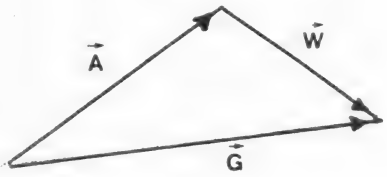
Program Title IN-FLIGHT WINDS | HEADWINDS AND CROSSWINDS

This program is actually in two parts: one to determine in-flight winds, and the other to resolve a wind into its headwind or tailwind and right or left crosswind components.

Determining In-Flight Winds

This program computes the winds at altitude from TAS, course of aircraft, ground speed and heading. Ground speed is automatically calculated from time-distance inputs. Winds can be computed as either magnetic or true. The latter must be used when verifying wind forecasts by the weather bureau. The program allows continuous updating of winds.

This program solves the wind triangle shown below.



OR $\vec{A} + \vec{W} = \vec{G}$

$\vec{W} = \vec{G} - \vec{A}$

W, **A** and **G** are all vector quantities representing wind direction and speed; TAS and heading; and ground speed and course respectively.

Since both **A** and **G** use magnetic directions, **W** is computed as a magnetic direction. It must be corrected to true heading by adding the variation V.

True wind direction = magnetic wind direction ± magnetic variation

Headwinds and Crosswinds

Also, this program calculates both the head wind and cross wind components from the aircraft heading and reported winds. The program works both at altitude, where magnetic variation must be considered, and at landing and takeoff, where winds are reported in magnetic directions rather than true directions.

HW= Head Wind
RCW= RightCross Wind
TW= Tail Wind
LCW= Left Cross Wind

The head wind (HW) and right cross wind (RCW) components are computed from

$$HW = K \cos (D - HDG + V)$$

$$RCW = K \sin (D - HDG + V)$$

where

K = the reported wind velocity

D = the reported wind direction

HDG = the aircraft heading

V = the magnetic variation (+ west, − east)

Necessary Accessories

Operating Limits and Warnings

Wind directions reported by the control tower are magnetic and the variation need not be input when using the program for takeoff and landings. Other wind directions are reported in true directions and variation must be included to find the wind components.

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "IFW"	
02	CF 05	
03	♦LBL 01	
04	CF 29	
05	FIX 1	
06	ADV	
07	RCL 06	
08	"VAR="	
09	XEQ 03	
10	STO 06	
11	FC? 55	
12	GTO 00	
13	CLA	
14	ARCL X	
15	XEQ "SYM"	
16	PRBUF	
17	♦LBL 00	
18	FIX 0	
19	RCL 04	
20	"MH="	
21	XEQ 04	
22	STO 04	
23	FS? 55	
24	XEQ 05	
25	FS?C 05	
26	RTN	
27	RCL 05	
28	"MC="	
29	XEQ 04	
30	STO 05	
31	FS? 55	
32	XEQ 05	
33	RCL 07	
34	"TAS="	
35	XEQ 03	
36	STO 07	
37	FS? 55	
38	XEQ 06	
39	RCL 02	
40	"GS="	
41	XEQ 03	
42	STO 02	
43	FS? 55	
44	XEQ 06	
45	RCL 04	
46	RCL 07	
47	P-R	
48	RCL 05	
49	RCL 02	
50	P-R	
51	X<>Y	
52	ST- T	
53	RDN	
54	-	
55	R-P	
56	RND	
57	STO 12	
58	X<>Y	
59	RCL 06	
60	-	
61	RND	
62	STO 11	
63	SF 21	
64	ADV	
65	"WIND DIR="	
66	XEQ "DGR"	
67	XEQ "PR"	
68	"WIND VEL="	
69	ARCL 12	
70	FS? 55	
71	GTO 07	
72	CF 21	
73	AVIEW	
74	RTN	
75	GTO 01	
76	♦LBL "HCW"	
77	♦LBL 02	
78	SF 05	
79	XEQ 01	
80	RCL 11	
81	"WIND DIR="	
82	XEQ 04	
83	STO 11	
84	FS? 55	
85	XEQ 05	
86	RCL 12	
87	"WIND VEL="	
88	XEQ 03	
89	STO 12	
90	FS? 55	
91	XEQ 06	
92	ADV	
93	RCL 11	
94	RCL 04	
95	-	
96	RCL 06	

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL'IFW
LBL'HCW
END 347 BYTES
AVIGATION/RNAV ■ 41C

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS
97	+	
98	RCL 12	
99	P-R	
100	"HW="	
101	X<0?	
102	"TW="	
103	ASTO 00	
104	ABS	
105	RND	
106	X<>Y	
107	"R"	
108	X<0?	
109	"L"	
110	"├CW="	
111	ABS	
112	ARCL X	
113	FC? 55	
114	"├ "	
115	FS? 55	
116	XEQ 07	
117	ARCL 00	
118	ARCL Y	
119	FS? 55	
120	XEQ 07	
121	CF 21	
122	AVIEW	
123	SF 21	
124	RTN	
125	GTO 02	
126♦	LBL 03	
127	FS? 55	
128	ACA	
129	ARCL X	
130	"├?"	
131	PROMPT	
132	RND	
133	RTN	
134♦	LBL 04	
135	FS? 55	
136	ACA	
137	CF 21	
138	XEQ "DGR"	
139	SF 21	
140	"├?"	
141	RDN	
142	PROMPT	
143	RND	
144	RTN	
145♦	LBL 05	
146	CLA	
147	XEQ "DGR"	
148	PRBUF	
149	RTN	
150♦	LBL 06	
151	CLA	
152	ARCL X	
153♦	LBL 07	
154	ACA	
155	SF 13	
156	"KTS"	
157	ACA	
158	PRBUF	
159	CF 13	
160	CLA	
161	END	

VAR=-7.5°
MH=165°
MC=150°
TAS=110kts
GS=120kts

WIND DIR=273°
WIND VEL=32kts

VAR=-7.5°
MH=165°
WIND DIR=273°
WIND VEL=32kts

RCW=31kts
TW=6kts

VAR=0.0°
MH=280°
WIND DIR=240°
WIND VEL=25kts

LCW=16kts
HW=19kts

Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.

LBL"R
LBL"V
END
TIMS

92 BYTES

PROGRAM DESCRIPTION I

Program Title Groundspeed along MC

Contributor's Name Robert A. Tims

Address

City **State/Country** **Zip Code**

Program Description, Equations, Variables Computes the groundspeed using DME and waypoint data or MC and Omni Bearing data. LBL "R" uses DME and waypoint distance and LBL "V" uses MC and Bearing to or from the VOR. Both methods use the tangential speed readout from the DME.

Necessary Accessories NONE

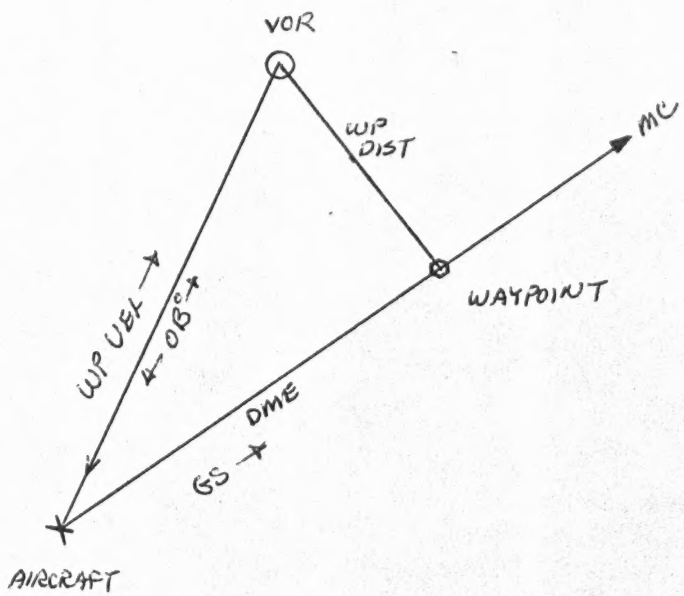
Operating Limits and Warnings Not very accurate when the bearing from the VOR is perpendicular to the MC or if the aircraft is within 10NM of the waypoint.

LBL'R
LBL'V
END 92 BYTES
TIMS

PROGRAM LISTING

FIX 2 ■ 41C

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
01	♦LBL "R"				
02	1				
03	STO 00				
04	"WP DIST?"				
05	PROMPT				
06	STO 01				
07	♦LBL 01				
08	RCL 01				
09	"DME?"				
10	PROMPT				
11	/				
12	X↑2				
13	1				
14	+				
15	SQRT				
16	GTO 00				
17	♦LBL "V"				
18	2				
19	STO 00				
20	"MC?"				
21	PROMPT				
22	STO 01				
23	♦LBL 02				
24	RCL 01				
25	"OB?"				
26	PROMPT				
27	-				
28	1				
29	P-R				
30	R-P				
31	RDN				
32	COS				
33	1/X				
34	ABS				
35	♦LBL 00				
36	"WP VEL?"				
37	PROMPT				
38	*				
39	FIX 0				
40	CF 29				
41	"GS="				
42	ARCL X				
43	"KNM"				
44	PROMPT				
45	GTO IND 00				
46	END				



Note: Refer to "HP-41C OWNER'S HANDBOOK AND PROGRAMMING GUIDE" for specific information on keystrokes. The Function Index is found at the very back of the Handbook.